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Boston Transit Commission.

Fourth Annual Report.

August 15, 1898.

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Estate of James B. Noyes

FOURTH ANNUAL REPORT

OF THE

BOSTON TRANSIT COMMISSION,

FOR THE YEAR ENDING

AUGUST 15, 1898.



BOSTON:
ROCKWELL AND CHURCHILL PRESS.
1898.

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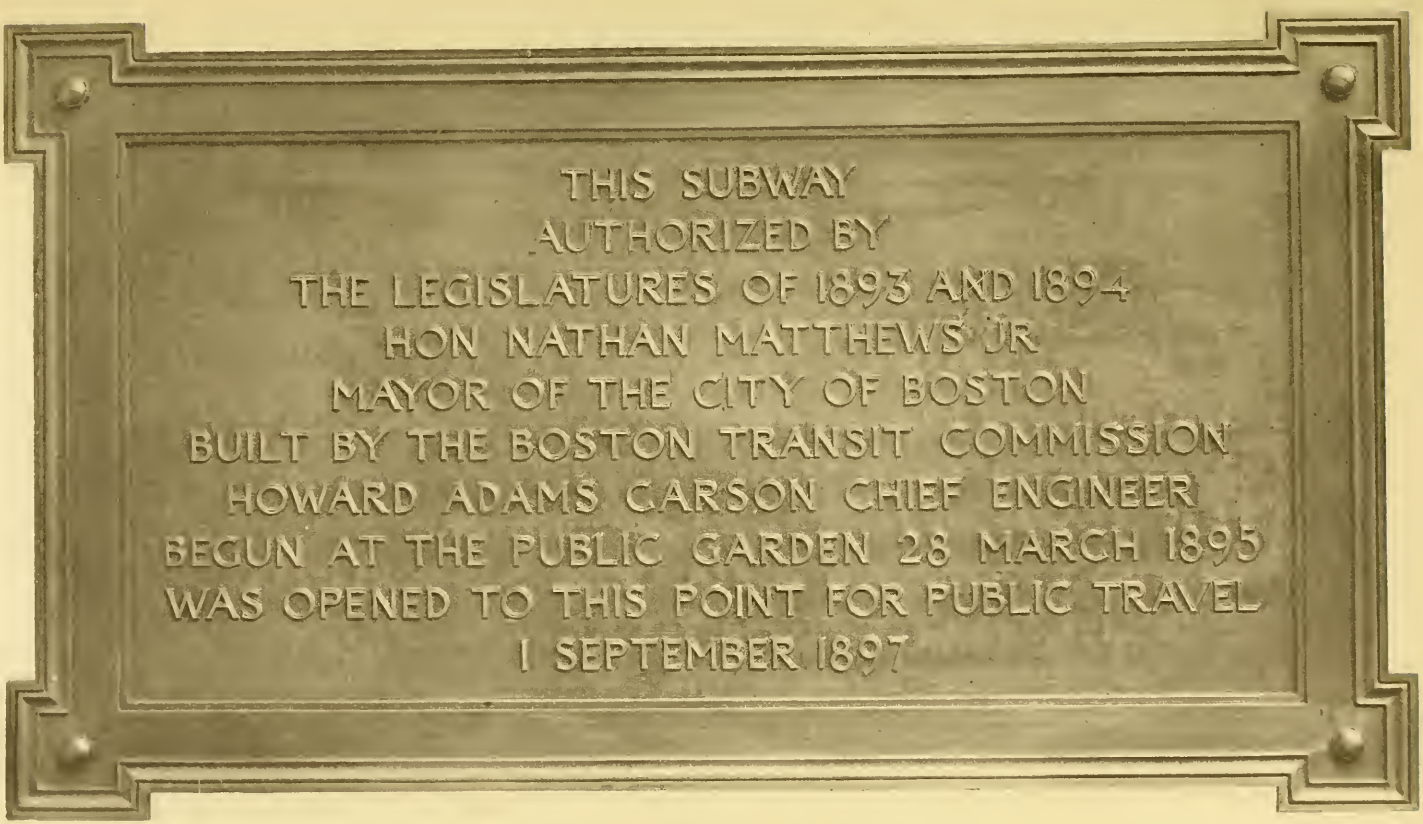
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Vol. 4

Estate of James B. Myers

December 30, 1949



E. L. SMITH, PHOTOGR.

THE HELIOTYPE PRINTING CO., BOSTON

BRONZE TABLET AT PRINCIPAL ENTRANCE TO PARK-STREET STATION.

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BOSTON TRANSIT COMMISSION.

20 Beacon Street,
Boston, Aug. 15, 1898.

To the City Council of the City of Boston:

In compliance with Statutes of 1894, chapter 548, section 24, the report of the Boston Transit Commission for the year ending Aug. 15, 1898, is respectfully submitted.

Completion of the Subway.

Work on the subway was begun on March 28, 1895, at the Public Garden, in the presence of His Excellency the Governor, Frederic T. Greenhalge, and the members of this Commission, and on the date of this report is finished, the work of construction covering a period of three years, four months, and eighteen days. The act required "that all streets and places under or near which a subway is constructed shall be open for traffic between eight o'clock in the forenoon and six o'clock in the afternoon," which requirement has been complied with.

Work of the Year.

Details of the work done during the year in completing the subway from Scollay square to the northern terminus will be found in the accompanying report of the Chief Engineer, as well as a summary of all the work of the engineering department from the beginning.

Opening of Sections 1, 2, and 3 for Use.

Pursuant to the vote of Aug. 13, 1897 (see last annual report), by which the West End Street Railway Company was notified that the use of Sections 1, 2, and 3 (from the Public Garden to Park street) should begin on Sept. 1, 1897, the said sections were opened to public service on that date.

In commemoration of this event, a bronze tablet has been placed in the northwestern entrance to the Park-street station, inscribed as follows:

THIS SUBWAY
AUTHORIZED BY
THE LEGISLATURES OF 1893 AND 1894
HON. NATHAN MATTHEWS JR
MAYOR OF THE CITY OF BOSTON
BUILT BY THE BOSTON TRANSIT COMMISSION
HOWARD ADAMS CARSON CHIEF ENGINEER
BEGUN AT THE PUBLIC GARDEN 28 MARCH 1895
WAS OPENED TO THIS POINT FOR PUBLIC TRAVEL
1 SEPTEMBER 1897

OPENING OF SECTIONS BETWEEN BOYLSTON AND PLEASANT STREETS.

On Sept. 20, 1897, the following vote was passed:

Voted, That, in accordance with the provisions of a contract between the city of Boston, acting by the Boston Transit Commission, and the West End Street Railway Company for the use of the subway, dated Dec. 7, 1896, a notification be sent to the company that, in the judgment of the Commission, that portion of the subway from near the corner of Boylston and Tremont streets under the Common to Pleasant street, known as Sections 4 and 5, can be advantageously used before the completion of the whole subway, and said portion of the subway having been substantially completed, the Commission has determined that, allowing a reasonable time to the party of the second part for the completion of the equipment thereof, the use of such portion shall begin on or before the first day of October next.

On Sept. 30, 1895, Sections 4 and 5 (from Pleasant street to Boylston street) were opened to public service, since which date the sections from 1 to 5 inclusive have been in use.

The number of passengers taking the cars at the Tremont-mall stations during eleven months ending August first current, as officially reported to the Commission, was 6,640,-043. As approximately the same number entered the subway in the cars at the inclines, the total number of passengers carried was over 13,000,000, being at the rate of about 14,500,000 a year. This was the traffic when less than one-half of the entire subway was in use, and before all the surface lines for that half had been transferred to it.

The service has been uninterrupted and, so far as the Commission is informed, without serious injury to passenger or employee. The equipment appears to have been adequate and the service to the public satisfactory. By the transfer

of a large number of cars from Tremont street to the subway the previously congested condition of the street was relieved, the car blockades, which for a long time had been of daily occurrence ceased, and the ordinary traffic moved with comparative freedom.

Opening of Sections 1 to 11, Inclusive, for Use.

On the date of this report, Aug. 15, 1898, the following vote was passed:

Whereas, In accordance with a notice dated 13 August, 1897, duly given to the West End Street Railway Company under the provisions of the contract between the city of Boston acting by the Boston Transit Commission and said company for the use of the subway, the use of a portion of the subway by said company under the provisions of said contract began on the first day of September, 1897; and

Whereas, The whole of the subway has now been completed by this Commission and the equipment thereof by the lessee nearly completed; and

Whereas, Under the provisions of said contract the use of the subway shall begin so soon as a reasonable time after its completion has been allowed the party of the second part for the equipment thereof:

Voted, That the use of the subway as a whole, under the provisions of said contract, shall begin on the first day of September next.

Copies of this preamble and vote were sent to the West End Street Railway Company and to the Boston Elevated Railway Company. At the date of this vote the equipment of the sections from Park street to Causeway street, though not entirely completed, was so far advanced that it promised to be done by September 1. It is the intention of the Boston Elevated Railway Company, in compliance with this vote, to have the entire subway open for public service on the date specified or within a few days thereafter. The equipment of these sections is being done by the Boston Elevated Railway Company with the same thoroughness as in Sections 1 to 5 inclusive.

Boston Common.

In completing the work of raising the grade of the westerly portion of the Common, generally known as the parade ground, the Commission seeded, in the first place, that portion which is south of the central path. This was done in the fall of 1896 and the spring of 1897. While the grass was growing there the section north of the central path was used as a playground. On Sept. 7, 1897, the Commission, in response to an inquiry addressed to His Honor the Mayor, received a letter stating that he had instructed the Superintendent of Public Grounds to throw open for use as a play-

ground a space south of the central path, and requested the Commission to take charge at once of the portion of the Parade Ground north of the central path, and to seed it down to grass. This was accordingly done.

On December 20, 1897, the care and custody of all portions of the Common were returned to the Superintendent of Public Grounds.

REMOVAL OF TRACKS ON TREMONT STREET AND ELSEWHERE.

The Act of 1894 requires that the Commission "shall order all tracks to be removed from Tremont street between Boylston street and Scollay square, and from Boylston street between Tremont street and Park square, and may order any other tracks which in its opinion may have been rendered unnecessary by the construction of said subways and tunnels, and which are above said subways and tunnels or within a distance of one thousand feet from any entrance to said subways and tunnels, to be removed from the streets," and also that "surface tracks shall not be laid or maintained in that part of any street from which said Commission may have ordered such tracks removed, as herein provided." The contract with the West End Street Railway Company for the use of the subway provides that the railway company will make no claim for any damage for removing upon the order of the Commission its surface track above mentioned, provided that no other persons or corporations are permitted to lay, maintain, and use tracks in these locations, and the company further agrees to restore and leave in good condition the pavements in the portions of the streets occupied by tracks so removed.

On Oct. 19, 1897, the following vote was passed, and a copy sent to the West End Street Railway Company:

Whereas, That portion of the subway included in Sections 1, 2, 3, 4, and 5 is completed, and is equipped with tracks for the running of all cars heretofore reversing at the Granary Burying Ground on Tremont street, and has passed into the custody and use of the West End Street Railway Company, as provided in the contract, thus in the opinion of this Commission rendering the third track and its connections with the main tracks at said locality unnecessary for the business of said company; and

Whereas, In the opinion of this Commission, the convenience and safety of the public require the removal of said third track and its connections with said main tracks at the earliest practicable moment; it is

Voted, That, in the opinion of this Commission, said track and its connections with said main tracks have been rendered unnecessary by the construction of said subway, and the same are hereby ordered to be removed in accordance with the provisions of chapter 548 of the Acts of 1894.

Pursuant to this vote the railway company, after arranging to turn into the subway at the Public Garden certain lines of cars from the south, which had previously reversed at the Granary switches, removed the said switches and siding and relaid the pavement as required by the act. This work was done without unnecessary delay, and the relief to the ordinary street traffic was at once apparent.

Stations at Scollay, Adams, and Haymarket Squares.

These stations have been finished in the same general manner as those under Tremont-street mall, the walls being faced with white porcelain tile or brick, and the columns encased in varnished wood to the height of seven feet.

The stairway covering at the Haymarket-square station was designed by the Chief Engineer.

The stairway coverings at Scollay and Adams squares were designed by Mr. Charles Brigham, architect, and built by Messrs. Woodbury & Leighton, contractors.

For the convenience of passengers entering these stations and intending to take trains at the North Union station, clock towers were built and furnished with clocks having dials to be illuminated at night.

In Scollay square there is one stairway for both entrance and exit, and one for exit only. Under the requirements of Acts of 1897, chapter 500, as hereinafter more fully set forth, the Scollay-square station was enlarged from its original plan by the addition of a platform on the east side one hundred and ninety-eight feet long, with an entrance and an exit at the corner of Brattle street, for which the estate at this corner was taken. This addition will give increased accommodation for the convenience of passengers at this important station.

Isolated Exits and Entrances important for the Safety of Passengers.

The following communication was received from the City Clerk, dated November 24, 1897:

City of Boston.
In Board of Aldermen.

Whereas, The city, at considerable expense, laid out Scollay square, in order to improve the means of transit in that vicinity; and

Whereas, The Boston Transit Commission proposes to erect a superstructure in said square in connection with the subway; and

Whereas, The erection of said superstructure will tend to obstruct transit in said square; therefore be it

Resolved, That, in the opinion of the members of the Board of Aldermen of the City of Boston, no superstructure should be erected in Scollay square, and if a station is required at this point in connection with the subway, a building should be secured on either side of the square and reconstructed in a suitable manner for the purposes of a subway station.

Adopted.

A true copy.

Attest:

(Signed) JOHN T. PRIEST,
Assistant City Clerk.

To which the following reply was sent:

BOSTON TRANSIT COMMISSION.
20 BEACON ST., BOSTON, Dec. 2, 1897.

To the Honorable Board of Aldermen of the City of Boston:

In respect to the resolution of your honorable board, of November 24th, relative to the Scollay-square subway station, the Boston Transit Commission deems it proper to submit herewith some considerations which have guided its general policy as to stations; and also some data touching Scollay square which, it is believed, will be of interest to the Board.

In planning so novel an enterprise in passenger traffic as is the subway, it was felt to be of the first importance to insure to the public the best possible security as to the stability of the structure and the safety at all times of the entrances and exits, especially the latter, so that in the event of, for example, a fire adjacent to stations, the exits should be so placed as to be easily protected and kept free for the use of passengers.

Your honorable body cannot fail to sympathize with the Commission in dealing with this grave responsibility.

The stations on the Tremont-street mall fulfil the conditions for safety, to perfection.

In the three other stations, *i.e.*, Scollay, Adams, and Haymarket squares, the greatest safety-point is always in the square itself.

Whatever additional entrances and exits may be needed in the near or distant future, to meet an increasing volume of traffic, the Commission believes the safety of the public requires that exits in the squares should always be retained.

The buildings adjacent to these squares are, in many cases, old structures, and are mostly filled with combustible merchandise. A moderate fire in these buildings, even for a short time, could, for such time at least, render an exit placed in or near to the burning building entirely useless.

The Commission has considered various plans and proposals for additional entrances and exits upon private property, and may find it to be desirable to adopt some of them; but it does not feel that it would be justified in doing away with the openings in the squares, as these, in some possible emergency, might be the only means of egress.

The area of Scollay square, exclusive of sidewalks, is 28,624 square feet; the area required by the proposed two stair coverings is 1,120 square feet, being 3.91 per cent. The area occupied by the old buildings and sidewalk was 5,000 square feet, being 4.46 times more than that of the stair coverings.

The width of the roadway at narrowest points between coverings and sidewalk curbs will be as follows:

	Feet.
East station, south side	28
north side	33
Total	61
West station, south side	20
north side	24
Total	44

Present width of roadway in Scollay square, near Hanover street, 39¼ feet.

The influence of the stair coverings will be to separate, and so expedite, the traffic. The platform in the subway is a large triangular island, available for all cars entering the station; without stairs to the surface it would be entirely useless. The present plan for this station is the outcome of many studies extending over more than two years, in connection with the officials of the West End Street Railway Company, and is, in fact, the one provided for in the contract between the city of Boston and the West End Street Railway Company for the use of the subway.

When the entire subway is open for use next summer, the square, relieved from the present street-car traffic, will be in a condition to accommodate the ordinary city traffic much better than ever before. The space in the middle of the square, between the east and west stair coverings, can then be used as a rank for the public cabs now standing at the curbs and greatly impeding travel; and the square will, both as a thoroughfare and an important business centre, enjoy increased advantages, equalled, perhaps, at no other point on the route of the subway.

Boston Transit Commission { GEORGE G. CROCKER, C. H. DALTON, THOMAS J. GARGAN, GEORGE F. SWAIN, HORACE G. ALLEN.

WIDENING OF CANAL STREET.

As provided by the act, the Board of Street Commissioners has, with the approval of the Mayor and this Commission, widened Canal street to 75 feet by adding a strip 25 feet wide, being a part of the land taken by the Commission from the Boston & Maine Railroad, and not needed for subway purposes. It is understood that the street is to be laid out with a 15-foot sidewalk on the west side and a 10-foot sidewalk on the east side, leaving 50 feet for the roadway.

PROPERTY BETWEEN HAYMARKET SQUARE AND TRAVERS STREET.

Chapter 347 of the Acts of the year 1897 provided for the transfer by the Boston Transit Commission to the city of Boston, to be used for a market or other public purpose, of so

much of the land taken by it between Haverhill and Canal streets as the Commission and the Mayor of the city should agree upon. The following letter was received from His Honor the Mayor under date of Feb. 28, 1898:

To the Boston Transit Commission:

GENTLEMEN: I have before me a blue print of plan No. 3874, showing the Haymarket-square property taken by your Commission, and the street-widening lines as informally agreed upon with the Street Commissioners, and I desire to notify your Commission that the city of Boston requires for street widenings, for a site for an engine house, which will require some 5,000 feet, and for a site for a public retail market, or for some other municipal use, the whole of the land bounded by Haymarket square, Canal street, Travers street, and Haverhill street, purchased by your Commission from the Boston & Maine Railroad Company, excepting so much as may be required for the purpose of constructing the subway. I understand that the area outside of the lines of the subway walls amounts to 51,524 feet, and that there is also an area of 19,526 feet over the subway incline. I desire to include the latter area as well as the former, as I believe that it will be possible for the city to utilize the space over the incline profitably for some municipal building, in such a manner as not to interfere with the use of the subway. I shall be ready to consider at any time with your Board what price shall be fixed upon this land in transferring it from your Commission for these other municipal uses.

Yours respectfully,

(Signed) JOSIAH QUINCY,
Mayor.

Following the receipt of this letter it was agreed by the parties interested to have the value of the land determined by appraisers, one to be appointed by His Honor the Mayor and one by the Boston Elevated Railway Company. His Honor the Mayor selected Mr. John C. Cobb and the railway company Mr. Frederick H. Viaux. It was arranged that if these two appraisers could not agree they should select a third one. At this date they have not made a report.

DISCONTINUANCE OF TRAVERS STREET.

On July 12, 1898, the Commission passed the following vote:

Whereas, In order to provide a gradual incline from the northerly portion of the subway to the elevated structure in Causeway street, as set forth in Statutes 1897, chapter 500, section 12, it is necessary to discontinue Travers street from the southwesterly line of Haverhill street to a line parallel therewith and distant fifty-two feet southwest therefrom; and

Whereas, The other provisions of said act preliminary to such discontinuance have been complied with, now therefore, pursuant to the requirements of said act, it is

Voted, That that portion of Travers street between the lines aforesaid be and hereby is discontinued.

TRAFFIC STATISTICS.

Park-street Station.

The area of this station is about one acre. Its shape and dimensions were limited by a law passed to prevent undue encroachment on the Common, and in some degree by a desire so far as possible to save trees. The cost of its construction was about $350,000.

The present traffic of the company indicates that during the first year of the use of the subway as a whole the number of passengers taking and leaving the cars at this station will be at least as great as the number of passengers entering and leaving Boston by steam-railroad trains at the Northern Union station, or about 24,000,000, and also greater than the aggregate number of passengers last year entering the city by all the other steam roads which are soon to occupy the new South Union station.

Scollay-square Station.

Under the date of Oct. 26, 1897, in response to an inquiry of the Commission, the following copy of a communication was received from the West End Street Railway Company:

BOSTON, Oct. 25, 1897.

SAMUEL LITTLE, ESQ., *President:*

DEAR SIR: As requested by the Transit Commission an account has been taken of the present traffic supposed to be tributary to the proposed Scollay-square station, summary of which is herewith submitted. All cars from the north of Lynn & Boston and West End Street Railway which terminate in Scollay square are described as Lynn & Boston and West End loop; all other cars are described as through cars, with the exception that the Belt Line and the Ferry cars are not included in the statement, for the reason that no provision is made for them in the subway.

The account was taken on Saturday, October 16th, Monday, October 18th, and Wednesday, October 20th, from 6 o'clock to 10 o'clock A.M., and from 4 o'clock to 8 o'clock P.M., but the figures here given show only the heaviest hours. The account for inward-bound loop cars was taken at Sudbury and Portland streets, and for the outward-bound cars at Hanover and Portland streets; for the through cars men were stationed at the following points: Tremont and School streets, Boston Museum, Scollay square, Cornhill, Hanover and Court streets, and Hanover and Portland streets; these men observed the passengers on and off through cars at the above points.

The statement herewith shows the maximum hour in the afternoon, 5 to 6, for the maximum day, which was Saturday, 16th inst., and the average for the three days at the same hour; also the maximum forenoon hour, 7 to 8 o'clock, for the maximum day, Monday, 20th inst., and also the average for the three days at the same hour; it also shows the maximum number of cars for the 20th inst., 7 to 8 A.M. and 5 to 6 P.M.

It is of course obvious that any statement or account made of the traffic at present furnishes but little indication of the demands of the future in this station. The rapid increase of population in the district served north of Boston which is taking place, the development of the Revere Beach business, etc., all point to enormous growth in the near future of the traffic probably tributary to Scollay square as a terminal; but the statement submitted, it is believed, gives a correct indication of the existing condition of traffic, a much smaller volume of traffic than the maximum conditions which were met the past summer and are likely to be met the coming summer.

Very truly yours,

(Signed) C. S. SERGEANT,
General Manager.

ACCOUNT OF PASSENGERS NOW CARRIED, SUPPOSED TO BE TRIBUTARY TO SCOLLAY-SQUARE SUBWAY STATION WHEN COMPLETED.

Maximum P.M. Hour, 5 to 6.

	Maximum Day, 10-16-97.			Average, Three Days.		
	On.	Off.	Total.	On.	Off.	Total.
Lynn & Boston loop..	1,313	258	1,571	1,250	179	1,429
West End loop	1,622	560	2,182	1,471	505	1,976
Total loop	2,935	818	3,753	2,721	684	3,405
Through cars	826	429	1,255	431	159	590
Total.....	3,761	1,247	5,008	3,152	843	3,995

Maximum Forenoon Hour, 7 to 8 A.M.

	Maximum Day, 10-20-97.			Average, Three Days.		
	On.	Off.	Total.	On.	Off.	Total.
Lynn & Boston loop..	62	802	864	55	666	721
West End loop	51	792	843	50	653	703
Total loop	113	1,594	1,707	105	1,319	1,424
Through cars	132	521	653	56	265	321
Total.....	245	2,115	2,360	161	1,584	1,745

NOTE. — The above figures exclude Belt Line and Ferry cars.

CARS.

Maximum Day, October 20, 1897.

	7 to 8 A.M.	5 to 6 P.M.
Lynn & Boston loop	46	44
West End loop	48	45
Total	94	89
Through cars	124	150
Total	218	239

VENTILATION.

On Jan. 18, 1898, the following communication was addressed to the Boston Elevated Railway Company:

BOSTON TRANSIT COMMISSION.

20 BEACON STREET,
BOSTON, Jan. 18, 1898.

WILLIAM A. GASTON, ESQ., *President Boston Elevated Railway Company:*

SIR: *Whereas*, The subway was planned and constructed with the view of placing therein ventilating fans to be installed and operated by the lessee, as provided in the contract with the West End Street Railway Company; and,

Whereas, The said company had not, at the time when the Boston Elevated Railway Company succeeded to said contract, made such installation;

Now, therefore, this Commission begs to call your attention to the matter, that it may receive from you such consideration and action as its importance requires.

The Commission has kept records of the temperature within and without the subway for many months, which are open to your examination if you so desire.

Since Sections 1 to 5, inclusive, have been in use, *i.e.*, from September first and October first, the general atmospheric conditions therein have been satisfactory, both as to purity and temperature, barring a day or two when, on a sudden rise in the outside temperature, with an excess of moisture in the air, there was condensation in the subway, which would probably have been diminished by the proper use of ventilating fans.

From the short experience of the past four and a half months it does not appear that fans are essential for keeping the air pure and wholesome during the autumn and winter seasons, though when the subway is in full use they may be sometimes needed. It is, however, in the hot summer days that fans may be imperative for a proper equalization of the temperature.

When the records of temperature were taken during last summer the subway was not in use, and the air was probably more stagnant than now when cars are running, and the variations between inside and out-

side temperatures were presumably in excess of what they will be next summer.

The records show variations as high as 18°, for example:

	Outside.	Inside.	Variation.
June 25	82°	66°	16°
July 1	82°	66°	16°
July 6	87°	69°	18°

If box cars were used in warm weather the objection to a change in temperature of 16° or 18° when entering the subway would be comparatively slight, but in open cars, running at high speed, with passengers in summer dress, variations would be much more objectionable.

The Commission is of the opinion that the installation of fans is necessary, and that they should be ready for use by the time the warm season opens.

By order of the Commission,

B. LEIGHTON BEAL,
Secretary.

On May 25, 1898, the Commission was notified by the President of the Boston Elevated Railway Company that the contract had been made for ventilating apparatus to be installed in the subway.

ALTERATIONS MADE AND TO BE MADE IN THE SUBWAY FOR THE USE OF THE ELEVATED RAILWAY COMPANY AS REQUIRED BY STATUTE 1897, CHAPTER 500.

Chapter 500 of the Acts of the year 1897, entitled "An Act to Promote Rapid Transit in the City of Boston and Vicinity," embodies amendments of the charter of the Boston Elevated Railway Company, and requires the Commission, under certain conditions, to make alterations in the subway for the use of that company, and to build a tunnel to East Boston. That portion of section 12 of said Act which relates to alterations of the subway is as follows:

Said corporation shall not construct, maintain, and operate its railroad in the subway now constructed or in process of construction, and now leased to the West End Street Railway Company, unless said street railway company shall, under the provisions of said lease, assign to said corporation its rights, powers, and privileges thereunder, or otherwise consent to such construction, maintenance, or operation; and in such event said corporation may construct and, during the term of the existing and any future contract for the use of the subway, may operate its railroad in said subway. In such event, upon the request of said corporation and upon its agreement that the cost thereof shall be considered as part of the cost of the subway under the existing contract with said West End Street Railway Company for the use of the same, the Boston Transit Commission shall make such alterations in the subway, and the approaches thereto, as may be necessary to render the same suitable for the running of cars and trains of cars through the

same, in connection with the elevated structure, upon the routes hereinbefore granted.

Pursuant to the provisions of the foregoing act, the West End Street Railway Company having assigned its lease of the subway to the Boston Elevated Railway Company, alterations in the subway, as requested in the following communications from the Boston Elevated Railway Company, have been made:

JAN. 12, 1898.

BOSTON TRANSIT COMMISSION, *20 Beacon street, Boston, Mass.:*

GENTLEMEN: I am instructed by the Boston Elevated Railway Company to request your Board to make alterations in the Scollay-square station of the subway, in accordance with a plan drawn by your engineers entitled "Study for additions to the Scollay-square station," and numbered "Plan No. 3627," except that we suggest, however, that the width of the stairways be increased to the greatest possible limit within the lot in which the stairways and passages are located; and that the niche for the ticket offices be placed one span, or about eight feet, further from the stairway.

These suggested alterations to said "Study for additions to Scollay-square station" are suggestions contained in letter dated "Boston, Nov. 16, 1897," and signed by A. L. Plimpton, E. K. Turner, and George A. Kimball, a copy of which I enclose.

All these alterations are requested under section XII. of chapter 500 of the Acts of 1897.

I hereby agree, on behalf of the Boston Elevated Railway Company, in accordance with the provisions of said section XII., that the cost of these alterations shall be a part of the cost of the subway, under the existing contract with said West End Street Railway Company, said contract with said West End Street Railway Company being dated Dec. 7, 1896.

Yours very truly,

(Signed) WILLIAM A. GASTON,
President.

BOSTON, Nov. 16, 1897.

Having examined Plan 3627, entitled "Study for additions to Scollay-square station," submitted this day by H. A. Carson, Esq., Chief Engineer of the Boston Transit Commission, the undersigned will respectfully report as follows:

We approve the general features of the said plan. We would, however, suggest that the width of stairways be increased to the greatest possible limit within the lot in which the stairways and passages are located, and that the niche for the ticket-office be placed one span, or about eight feet, further from the stairway.

A. L. PLIMPTON,
E. K. TURNER,
GEORGE A. KIMBALL.

BOSTON, MASS., April 29, 1898.

To the Boston Transit Commission, 20 Beacon street, Boston, Mass.:

GENTLEMEN: We have requested you since January 1st to make the following alterations in the subway, the expense of which it is hereby

agreed shall be considered as a part of the cost of the subway under the existing contract between the city of Boston and the West End Street Railway Company, viz.:

1. Additional easterly platform, Scollay square.
2. Alterations of stairs, south-bound platform, Park-street station.
3. Alterations of lines of stairs, Haymarket-square station.
4. Change of grade, Hanover street, near Scollay square.
5. Change of grade, Adams-square station.

This agreement I am authorized to make on behalf of the Boston Elevated Railway Company by virtue of a vote of the Executive Committee thereof, a certified copy of which vote I herewith enclose.

Yours very truly,

WILLIAM A. GASTON,
President.

BOSTON, April 29, 1898.

At a meeting of the Executive Committee of the Boston Elevated Railway Company held this day, it was

Voted, That the president be and he hereby is authorized to agree that the cost of the following changes which have been made in the subway at the request of this corporation shall be considered a part of the cost of the subway, under the existing contract of the West End Street Railway Company with the city of Boston:

1. Additional easterly platform in Scollay square.
2. Alterations of stairs, south-bound platform, Park-street station.
3. Alteration of lines of platform, Haymarket-square station.
4. Change of grade, Hanover street, near Scollay square.
5. Change of grade, Adams-square station.

A true copy.

Attest:

(Signed) JOHN T. BURNETT.

Height of Station Platforms.

In response to an inquiry as to whether any changes were necessary in the height of station platforms the Commission received the following communication:

BOSTON ELEVATED RAILWAY COMPANY,
81 MILK STREET.

BOSTON, MASS., Jan. 10, 1898.

HON. GEORGE G. CROCKER, *Chairman of Boston Transit Commission, 20 Beacon street, Boston:*

DEAR SIR: In response to your communication of December 14th last, addressed to the Boston Elevated Railway Company, in regard to the proper heights of the various sections of the platforms under Scollay, Adams, and Haymarket squares, also in respect to changes, if any, deemed desirable in the height of the platforms now in use, I beg to submit the following:

It is the opinion of this company that the Scollay-square platform should be 13 in. above the rail, except at one place on the curve at Cornhill, shown on a blue print herewith attached, dated Dec. 20, 1897. Here we think the platform should be depressed to 2 in. above

the rail as shown on the drawing, and that the depressed part be connected by easy slopes with the general level of the platform.

At Adams square the platform, we think, should be 13 in. above the rail except at one place on the short radius loop. This could be helped by lowering the platform to 6 in. above the rail and extending it out as far as the ties, and then connecting this lowered area by easy slopes with the general level of the platform in much the same way as already proposed at Scollay square.

At Haymarket square the platform, we think, should be 13 in above the rail throughout.

We make no suggestions as to any changes in the height of the platforms now in use, but later we may desire to say something about a change in the Park-street platforms.

Respectfully,

(Signed) WILLIAM A. GASTON,
President.

Alterations of Plan at Northern Terminal.

When the Act of 1897 was passed the northern terminal of the subway had not been constructed. Plans had been made for that terminal, to meet the requirements of the traffic of the West End Street Railway Company as it up to that time had been operated. It was contemplated to provide for the cars from the south, having the North Union station as a terminus, an underground station and loop, to which access could be had by a passageway under Causeway street, in addition to the other exits and entrances. This loop would connect the two outside tracks of the subway, while the two inside tracks would be used for the traffic coming from the north having a terminus at Scollay square. The general features of the plan as contemplated are shown in the second annual report in the last diagram of Plate 1, opposite page 24.

When the method of operation which the Elevated Railway Company proposed to adopt was laid before the Commission, it was found that it differed essentially from the plan of operation which had been followed in running the surface cars, in that it was proposed to use the outside tracks for through traffic having a terminal at Sullivan square in Charlestown instead of a terminal at the Union Station. It was necessary, therefore, to give up the idea of an underground station at Causeway street, and to bring the outside tracks as well as the inside tracks to the surface at a point near Travers street, to be carried on from that point as the Elevated Railway Company may see fit. It is understood that it is the intention of the Company to continue the incline of the outside tracks so as to make them elevated tracks before reaching Causeway street, and to continue the two inside tracks

as surface tracks for the use of its surface cars and those of the Lynn & Boston Railroad.

Alterations at the Pleasant-street Terminal.

When the plans of the Elevated Railway Company, which, under the Act of 1897, had been submitted to the Board of Railroad Commissioners for approval, were examined by this Commission, it was found that if adopted they would render necessary extensive alterations at the Pleasant-street entrance to the subway, which would cut off all connection between the subway tracks and the surface tracks on Shawmut avenue and Tremont street. The Commission thereupon asked for a hearing before the Board of Railroad Commissioners, and, such hearing being given, urged that the plans should not be approved until amended. The position taken by the company was that train service on the elevated road was practically a necessity; and that all surface cars from Shawmut avenue and Tremont street should be barred from entering the subway, and the two outer tracks devoted exclusively to the elevated service. This Commission, on the other hand, took the position that the elevated road could and should for the present be operated with single cars, rendering unnecessary a change of cars at Pleasant street and at Dudley street, that a subway for the Washington-street traffic, which is now needed, and for which there seems to be a growing public demand, would be better adapted to an elevated train service, and that it was inadvisable to adopt a method of operation or to make alterations in the subway which would bar the surface cars from entering it at the Pleasant-street terminal. Subsequently the Elevated Railway Company and the Commission submitted written communications upon the subject.

The Commission submitted a plan by which entrance to the subway without any crossing at grade was secured both for the surface cars from Tremont street and Shawmut avenue, and for the elevated railway cars. The Commission urged that if the Board of Railroad Commissioners should be of the opinion that two tracks through the subway should be devoted to the train service of the elevated railway to the exclusion of surface cars, then the plans of the company should be so changed as to make connection within the subway with the tracks now devoted to the Shawmut-avenue traffic, which connection could be made with but little expense and without material alterations of the company's plans for approach to the subway, and would leave the con-

nection with the Tremont-street tracks unimpaired and ready for use at such time in the future as another and better route for the elevated road should be secured.

The plan of the Elevated Railway Company without amendment was approved by the Board of Railroad Commissioners. By it the inbound elevated railway track is connected within the entrance to the subway with the present inbound Shawmut-avenue track, and the outbound elevated track is connected with the present outbound Tremont-street track, and all connection between the surface tracks and the subway is cut off.

It will be observed that the change involves a radical departure from the plan and purposes of the subway as originally authorized and built and as now operated. The route for the subway selected by the Legislature was well adapted to a service of street cars running singly or in pairs, but it was not so well adapted for a train service, for which a route with fewer curves and less severe grades would have been better. The original charter of the Boston Elevated Railway Company which formed part of the same act which authorized the construction of the subway (St. 1894, ch. 548) did not contemplate the running of the cars of the company through the subway. The subway was constructed to meet the requirements of the surface lines. A large expenditure has been incurred at the Pleasant-street terminal to permit the traffic of the two tracks on Tremont street south of Pleasant street, and the two tracks on Shawmut avenue, to be consolidated on two tracks in the subway without crossings at grade. This expensive construction will be worse than useless if the alterations proposed by the company are carried out.

Cambridge-street Subway.

By section 5 of the aforesaid chapter 500 of the Acts of the year 1897 this Commission is required, when certain preliminaries have been complied with, to construct an incline, open cut, and subway beginning at a point on Cambridge street near North Russell street, upon, through, and under Cambridge street, Bowdoin square, and Court street, to a junction at Scollay square with the present subway.

No such junction can be made at Scollay square without crossings at grade which would be fatal to the usefulness of the present subway. The citizens of Cambridge already have connection with the subway over Harvard bridge. The traffic coming in over the new West Boston bridge should

connect with the tracks, either elevated or in subway, which may soon be required to accommodate the Washington-street traffic, and until such subway or elevated tracks are built the West Boston bridge traffic should have a terminal near to and with convenient access to the Scollay-square station, but not connecting with it. In the opinion of the Commission the provisions of said section 5 should be modified. The problem of providing an underground route, stations, and connections for the Cambridge traffic over the West Boston bridge is a serious and difficult one. It cannot be solved without much careful study, and should not be hastily undertaken.

The present subway was designed to meet the problem of carrying the traffic on the Tremont-street route. Its capacity is more than sufficient, when fully utilized, for all the cars that can be accommodated on the streets at its entrances. It forms a connected and consistent whole, and no other lines of traffic can be connected with it without interfering with the work which it was specifically designed to do.

If it is to be the policy of the city to continue the work of securing more rapid transit, and of relieving the streets either by elevated roads or subways, the routes thereof should be laid out only in accordance with a well-defined plan, all parts of which should be adapted to the others and no part of which should impair the usefulness of any other.

COST OF THE SUBWAY.

The estimated cost of the subway as made in 1894, before the work was begun, and as publicly announced in response to legislative inquiry when the bill for the repeal of the subway act was pending, was $5,000,000.

The work is completed. Some final payments are not yet due, but the amount to be paid to the various contractors in final settlement has in all cases been agreed upon. Some suits for damages to person and property are still pending. These are suits in which the Commission believes that the claims are not well founded.

Certain real estate no longer needed is to be disposed of, and the proceeds thereof credited.

It is therefore impossible as yet to state with exactness the cost of the subway, but it is believed that it will be less than $4,250,000, exclusive of the cost of the alterations required by an act passed in 1897, elsewhere referred to, ordering the Commission to make alterations in the

subway to adapt it to the use of the elevated railway. The amount expended on this alteration account, up to Aug. 15, 1898, was $64,229.61.

Charlestown Bridge.

The work of building the new bridge to Charlestown has been carried on with little interruption during the past year. The ten masonry piers, the main portions of the two abutments, and eight spans of steel superstructure have been completed.

All of the steel superstructure to complete the bridge, and all the masonry excepting such as may be needed for the Boston approach, have been contracted for, and contracts have also been awarded for the special stone paving, and the water-proofed wooden flooring and interior painting of the ten water spans.

By section 12 of chapter 500 of the Acts of the year 1897 the Commission was instructed to design and construct the bridge so as to support safely the tracks of the Boston Elevated Railway Company, and it was further provided that any alteration in the plan or structure of said bridge thereafter made by the Commission in order to secure such additional strength should be paid for by said corporation. The bridge having been originally designed to carry an elevated railway, no alterations in the plan or construction of the bridge were required.

On Aug. 25, 1897, the Commission petitioned the Board of Railroad Commissioners for the consent of that Board, under section 120 of chapter 112 of the Public Statutes, for the construction of the northerly approach to the bridge at a height of less than eighteen feet above the tracks of the Fitchburg Railroad, and after notice to the city and to the Fitchburg Railroad and a public hearing, the Board of Railroad Commissioners issued the following order:

Commonwealth of Massachusetts.

In Board of Railroad Commissioners, Sept. 14, 1897.

In the matter of the petition of the Boston Transit Commission for the consent of the Board, under section 120 of chapter 112 of the Public Statutes, to the construction of the northerly approach to the new bridge which said Commission is required by section 30 of chapter 548 of the Acts of 1894 to build over Charles river, at a height of less than eighteen feet above the tracks of the Fitchburg Railroad near Charlestown City square, in the city of Boston, — after notice to said city and to the Fitchburg Railroad Company and a public hearing, — it is

Ordered, That the Board consent to the construction and maintenance of said bridge or the approach thereto, at the place aforesaid, at a clear height of not less than sixteen feet above the said railroad tracks, as the

same are now graded, or as the same may hereafter be graded and maintained under an agreement in writing of said railroad company with the city of Boston or with said Transit Commission for the depression of said tracks at the place aforesaid.

Attest: (Signed) WM. A. CRAFTS, *Clerk.*

A true copy.
Attest: WM. A. CRAFTS, *Clerk.*

EAST BOSTON TUNNEL.

In response to an inquiry under date of Jan. 20, 1898, from the Common Council of the city of Boston made through His Honor the Mayor, for information as to the progress made in relation to the subway and tunnel to East Boston, the following letter was transmitted:

BOSTON TRANSIT COMMISSION.

20 BEACON STREET,
BOSTON, Feb. 5, 1898.

HON. JOSIAH QUINCY, *Mayor:*

DEAR SIR: In accordance with the request of the Common Council, dated January 20, and received through you at this office January 25, the Boston Transit Commission transmits a copy of a report made to it by the Chief Engineer, of the progress of the work with relation to East Boston tunnel, and also of a communication transmitted to the Legislature January 27.

BOSTON TRANSIT COMMISSION,
(Signed) By GEORGE G. CROCKER.

BOSTON TRANSIT COMMISSION.

20 BEACON STREET,
BOSTON, Feb. 4, 1898.

To the Boston Transit Commission:

Progress on study for East Boston tunnel.

GENTLEMEN: Two parties have been in the field since the latter part of last December, making surveys near the shore in East Boston and Boston proper on parts of the proposed routes, of which correct plans do not exist. Additional borings have been made in East Boston and Boston and under the harbor.

A somewhat hastily prepared estimate of cost was made Sept. 12, 1895. This plan contemplated one inclined approach to permit the surface cars to enter and leave the tunnel in Hanover street near Prince street, and another in East Boston at Maverick square. According to the Act of 1897, however, the termination of the tunnel and approaches near Prince street is not permissible, but the subway must be continued so as to connect with the present subway, thereby adding about two thousand feet of structure to the tunnel contemplated in the estimate of 1895, and involving much additional expenditure.

The following routes are under consideration, and a first draft of the estimate of cost for each of these lines has been made. All of these routes connect with the present subway not far from Scollay square in Boston, and have a terminus in Maverick square, East Boston.

Description.

ROUTE NO.

1. Hanover street to Battery street, through Battery street to near the head-house on the Boston side of the North Ferry, and under the harbor and private land in a direct line to Maverick square.
2. Hanover street to Battery street, through Battery street to near the head-house on the Boston side of the North Ferry, passing across the harbor nearly due east to the lower part of Lewis street, and thence in that street.
3. Hanover street to Fleet street, under Fleet street, Eastern avenue, South Ferry head-house on Boston side, and under Lewis street, East Boston.
4. Hanover street to Board alley, under private property, North street, Eastern avenue, South Ferry head-house on Boston side, and under Lewis street, East Boston.
5. Hanover, Blackstone, and Clinton streets, and Lewis street, East Boston.
6. Hanover street to Battery street, through Battery street to near the head-house on the Boston side of the North Ferry, passing northeasterly to near the head-house on the East Boston side of the ferry, and thence in Border and Sumner streets.
7. Hanover street to Fleet street, under Fleet street, thence under private property and harbor in a direct line to Maverick square.
8. Hanover street to Board alley, private property, North street to Fleet street, thence under private property in a direct line to Maverick square.
9. In Friend street and Dock square (two single-track branches) to Faneuil Hall, thence in South Market street to Atlantic avenue, and under Lewis street on the East Boston side.

All are indicated on the accompanying plan.

The next step is to select from these one route which seems on the whole to be most advantageous in point of economy, directness, and convenience to users. When this route has been selected, additional borings will be made and a more careful study made of the sewers, pipes, foundations of buildings, and other features along the route which will affect the design and cost. All of these plans contemplate a double-track subway (similar to that now under Cornhill) from the subway already existing to points not far from the harbor line. The part under the harbor will, according to the design under contemplation, consist of two single tubes. Each of the tubes is to be wide enough to accommodate a single line of surface or elevated cars of the ordinary size, and admit of a narrow path on each side which would allow passengers to walk in case the cars should be stopped for any reason. Each of the plans contemplates three new stations, one near Atlantic avenue and two others between Atlantic avenue and Washington street.

According to the first draft of these estimates the least expensive route will cost about three and three-fourths million dollars, and the most expensive about four million one hundred thousand dollars.

Yours respectfully,

(Signed) H. A. CARSON,
Chief Engineer.

The communication referred to above, which was transmitted to the Legislature on Jan. 27, 1898, was as follows:

BOSTON TRANSIT COMMISSION.

20 BEACON STREET,
BOSTON, Jan. 27, 1898.

To the Honorable the Senate and the House of Representatives in General Court Assembled:

Respectfully represents the Boston Transit Commission that by the Acts of the Legislature of the year 1897, chapter 500, it was provided that whenever the Boston Elevated Railway Company is authorized to begin the construction of its railway over the route first applied for, as provided in section 13 of the act, the Boston Transit Commission shall construct a tunnel or tunnels of sufficient size for two railway tracks, with approaches, entrances, sidings, stations, and connections therefor, and for the running of railway cars therein, from a point on or near Hanover street in the city of Boston or such other point or points as said Board may deem proper for a suitable connection with the subway or subways provided for in section 25 of chapter 548 of the acts of 1894, to a point at or near Maverick square in that part of Boston called East Boston, where a suitable connection with surface tracks may be made;

That to provide means for such construction the treasurer of the city of Boston was authorized to issue bonds to the amount of five hundred thousand dollars in addition to the seven million authorized for the construction of work contemplated by said Act of 1894, making a total of seven and a half million dollars;

That the estimate of cost of the subway now in process of construction as made before the work was begun was five million dollars;

That the estimate of cost, made in 1895, and previously reported, of building a tunnel or tunnels from East Boston to a convenient *exit* on Hanover street, was $2,406,600;

That based upon such estimates of cost the appropriation of seven and a half million dollars would have been sufficient to complete said subway and tunnel;

That the Act of 1897 requires the tunnel from East Boston to be continued so as to connect with the present subway, thereby adding nearly two thousand feet of structure to the tunnel contemplated in the estimate of 1895, and involving large additional expenditure;

That the preliminary but not final estimates of cost of building a tunnel or tunnels from East Boston and extending the same so as to connect with the present subway, in accordance with the Act of 1897, vary, according to the route which may be selected out of the nine which are under consideration, from three and three-quarter million to over four million dollars;

That based upon these estimates of cost the amount appropriated will be insufficient to complete the work in the manner required by the Act of 1897;

Wherefore, said Boston Transit Commission makes report as above, to the end that such action may be taken in the premises as to the General Court may seem fitting.

GEORGE G. CROCKER,
C. H. DALTON,
THOMAS J. GARGAN,
GEORGE F. SWAIN,
HORACE G. ALLEN,
Boston Transit Commission.

A hearing upon the foregoing communication was given by the Committee on Metropolitan Affairs on March 4, 1898. At this hearing the city was represented by His Honor the

Mayor and by the Corporation Counsel, both of whom expressed the opinion that it was not the intent of the Legislature of 1897 to require the tunnel to be connected with the subway, and that such was not the correct interpretation of the act. The opinion of the Corporation Counsel was subsequently transmitted to the Commission in the following letter:

CITY OF BOSTON.

LAW DEPARTMENT, 73 TREMONT STREET,
BOSTON, March 2, 1898.

TREMONT BUILDING,
ROOMS 730–741.

To the Boston Transit Commission:

GENTLEMEN: I have received your request for my opinion as to "whether under the Statutes of 1897, chapter 500, it is in the power of this Commission to so build a tunnel to East Boston that it will have an exit or exits on Hanover street without having, or being located with reference to, a suitable connection with the subway," and I have the honor to say that, in my opinion, under the provisions of section 17 of said chapter 500, the Commission is granted authority to do one of two things — to construct a subway to East Boston, either from the surface at a point on or near Hanover street, or from any subway which it is now building. I will give you my opinion more at length as soon as I have leisure therefor.

Respectfully,

(Signed) ANDREW J. BAILEY,
Corporation Counsel.

The committee reported that "No further legislation was necessary," and that report was subsequently adopted by the Legislature.

The Commission was by the Act of 1897 required to construct the tunnel so soon as the Elevated Railway Company should be authorized to begin the construction of its railroad over the route first applied for, as provided in Section 13 of the Act.

On July 11, 1898, the following votes were passed by the Board of Railroad Commissioners:

COMMONWEALTH OF MASSACHUSETTS.

IN BOARD OF RAILROAD COMMISSIONERS,
July 11, 1898.

The annexed plans, numbered and marked as in the above note * of George A. Kimball, Civil Engineer, are hereby approved, so far as they

* The following is the note referred to above:

The plans hereto attached and numbered 25350, 25351, 20551, 20253, 20254, 20255, 20256, 20257, 20258, 20259, 20401, 20402, 20403, 20405, and plans marked "CITY OF BOSTON, CHARLESTOWN BRIDGE DRAW SPAN, APRIL, 1898," SHEETS No. 1, No. 2, No. 14, and No. 15, all of which show details of construction and are filed by the Boston Elevated Railway Company with the BOARD OF RAILROAD COMMISSIONERS for their approval under chapter 500 of the Acts of 1897.

(Signed) GEORGE A. KIMBALL,
Civil Engineer.

show the proposed form and method of construction of elevated structure, and the strength and safety of such structure and of the bridge traversed thereby.

JOHN E. SANFORD,
(Signed) GEORGE W. BISHOP,
HERSEY B. GOODWIN,
Commissioners.

A true copy.
Attest:

WM. A. CRAFTS,
Clerk.

COMMONWEALTH OF MASSACHUSETTS.

IN BOARD OF RAILROAD COMMISSIONERS.

July 11, 1898.

The annexed plans, numbered 25021 to 25041, inclusive, are hereby approved, so far as they show the proposed location and grade of tracks and elevated structure, and the proposed location of the stations shown on said plans; but not as showing in other particulars the form and method of construction proposed. The Board reserves for future consideration the question of an additional station or stations.

JOHN E. SANFORD,
(Signed) GEORGE W. BISHOP,
HERSEY B. GOODWIN,
Commissioners.

A true copy.
Attest:

(Signed) WM. A. CRAFTS,
Clerk.

On July 14, 1898, the following letter of inquiry was addressed to the Board of Railroad Commissioners:

BOSTON TRANSIT COMMISSION, 20 BEACON STREET,
BOSTON, July 14, 1898.

BOARD OF RAILROAD COMMISSIONERS, JOHN E. SANFORD, *Chairman:*

GENTLEMEN: I am instructed by the Commission to ask your Board whether the Boston Elevated Railway Company has been authorized to begin the construction of its railway over the route first applied for by it within the meaning of section 17, chapter 500, Statutes 1897, and for the date of such authorization, if any.

Yours respectfully,
(Signed) B. LEIGHTON BEAL,
Secretary.

The reply was as follows:

COMMONWEALTH OF MASSACHUSETTS.

BOARD OF RAILROAD COMMISSIONERS.

BOSTON, July 15, 1898.

BOSTON TRANSIT COMMISSION, GEORGE G. CROCKER, *Chairman:*

GENTLEMEN: In reply to the inquiry by your secretary, under date of July 14, we would say that the Boston Elevated Railway Company has

not yet submitted to the Board all of the plans showing the form and method of construction proposed, which are called for by section 6 of chapter 500 of the Acts of 1897, and of course the Board has not yet approved all the plans called for by said section.

Very truly yours,

(Signed) JOHN E. SANFORD,
Chairman.

On July 19, 1898, it was

Voted, That the construction of the East Boston tunnel be proceeded with in accordance with the statute requirements.

PAYMENTS TO SINKING FUND.

The following premiums on bond issues and receipts from all sources have been paid into the Rapid Transit Sinking Fund during the year, not including income from investments or interest on deposits:

On Subway Account.

1897.		
Sept. 14.	Sale of clock, old Boston & Maine station	$35 00
Nov. 18.	Rentals of Haymarket-square property	2,535 40
1898.		
Jan. 1.	Premium on $200,000, 3½ per cent. bonds	11,778 00
Jan. 27.	For advertising privileges	40 00
Mar. 1.	Rentals, Brattle and Court streets (alterations)	200 00
May 19.	Sale of old rails	600 00
June 16.	Premium on $200,000, 3½ per cent. bonds (alterations)	6,940 00
June 28.	Sale of old furniture	110 00
July 7.	Rentals of Haymarket-square property	1,972 90
		$24,211 30

On Charlestown Bridge Account.

1897.		
Nov. 18.	Rentals of Charlestown Bridge property	$2,267 55
1898.		
Jan. 1.	Premium on $300,000, 3½ per cent. bonds	17,667 00
June 14.	Sale of old building materials	205 00
Aug. 15.	Rentals of Charlestown Bridge property	2,087 07
		$22,226 62

Condition of the Sinking Fund to date, including interest on investments:

Subway (including alterations)	$278,465 96
Charlestown Bridge	38,801 24

STATEMENT OF EXPENSES.

The following is a classified statement of the expenses of the Commission for the year ending Aug. 15, 1898:

SUBWAY.

General Expenses:		
Office — Repairs	$41 11	
Supplies	760 85	
Stationery and printing	2,358 57	
Fuel and light	223 77	
Rental	1,500 00	
Stenographers	3,356 98	
Messenger	942 00	
Clerks	832 00	
Janitor	244 38	
Salaries of Commissioners and Secretary	30,335 00	
Total	$40,594 66	
General Expenses: 4–5 to Subway		$32,475 73

ENGINEERING DEPARTMENT.

Rooms — Repairs	$70 32	
Furniture	5 72	
Supplies	1,871 93	
Stationery and printing	3,827 15	
Fuel and light and heat	457 08	
Rental	1,520 00	
Janitor	437 57	
Messengers	529 43	
Stenographers	2,473 07	
Instruments	107 93	
Supplies	6,754 13	
H. A. Carson	8,667 00	
Skilled service	44,351 56	
Total		71,072 89

MISCELLANEOUS.

Legal and expert advice	$922 00	
Advertising	99 75	
Labor	10,321 81	
Total		11,343 56
Carried forward,		$114,892 18

Brought forward,		$114,892 18

SECTION ONE.

(*Public Garden to old Public Library, 2-track; Tremont street from north of Mason to West street, 4-track; completed.*)

Jones & Meehan	$4,000 00	
Legal and expert advice	93 75	
Construction	1,088 70	
Teaming	72 24	
Field supplies	554 51	
Labor	947 68	
Granolithic work	2,080 20	
Total		8,837 08

SECTION TWO.

(*Old Public Library to north of Mason street, 2 and 4 track, and station; completed.*)

Wheelwright & Haven	$252 33	
Norcross Bros.	16,372 34	
Construction	2,376 99	
Legal and expert advice	136 42	
Field supplies	2,173 29	
Labor	1,889 78	
Granolithic work	8,529 83	
Total		31,730 98

SECTION THREE.

(*West street to Park street, 4-track, and station; completed.*)

F. E. Shaw	$15,000 00	
Pennsylvania Steel Co.	2,927 67	
Wheelwright & Haven	252 34	
Norcross Bros.	16,372 34	
Construction	2,867 55	
Office supplies	50	
Field supplies	2,179 29	
Labor	2,147 09	
Teaming	700 64	
Expert advice	367 03	
Granolithic work	9,644 32	
Total		52,458 77

SECTION THREE AND ONE-HALF.

(*About 25 feet each of two single-tracked subways from Section 3 to Section 6; completed.*)

Labor		19 50

SECTION FOUR.

(*Tremont street, Section 2, to Hollis street, 2-track; Hollis to Warrenton street, 4-track; completed.*)

Metropolitan Construction Co.	$22,021 84	
Construction	2,504 95	
Legal and expert advice	50 00	
Carried forward,	$24,576 79	$207,938 51

Brought forward,	$24,576 79	$207,938 51
Office supplies	1 78	
Field supplies	1,045 08	
Labor	5,342 61	
Teaming	562 57	
Water-pipes	49 37	
Electric conduits	50 32	
Total		* 31,621 21

SECTION FIVE.

(*Warrenton street to Pleasant street, 4-track, and incline; completed.*)

W. H. Keyes & Co.	$3,103 83	
Construction	664 97	
Legal and professional advice	240 25	
Office supplies	37	
Field supplies	173 13	
Teaming	227 58	
Labor	1,216 68	
Land damages	135,070 59	
Water-pipes	6 48	
Total		140,703 88

SECTION SIX.

(*Tremont street, Section 3½, to near Scollay square, 2-track; completed.*)

Construction	$1,608 53	
Office supplies	1 20	
Field supplies	4,289 50	
Teaming	1,058 53	
Labor	10,289 84	
Electric conduits	62 52	
Rental	41 67	
Water-pipes	145 08	
Total		17,496 87

SECTION SEVEN.

(*Scollay-square station; completed.*)

Shailer & Schniglau Co.	$53,109 79	
Carnegie Steel Co. (Ltd.)	15,733 67	
Woodbury & Leighton	12,500 00	
Hallstead & McNaugher	315 94	
Charles Brigham	750 00	
Construction	22,164 73	
Advertising	11 25	
Legal and expert advice	12 00	
Office supplies	239 12	
Field supplies	6,266 95	
Stationery and printing	52 87	
Teaming	3,133 88	
Labor	9,877 74	
Carried forward,	$124,167 94	$397,760 47

* $31,628.52 less $7.31 transferred to Section 11 account.

Brought forward,	$124,167 94	$397,760 47
Re-locating pipes	1,246 78	
Water-pipes	1,149 25	
Electric conduits	377 36	
Total		126,941 33

SECTION EIGHT.

(*Hanover street, Section 7 to Section 9, 2-track; completed.*)

Metropolitan Construction Co.	$2,874 15	
Construction	866 77	
Field supplies	312 66	
Teaming	58 57	
Labor	568 51	
Re-locating pipes	43 35	
Electric conduits	185 44	
Water-pipes	252 31	
Total		5,161 76

SECTION EIGHT AND ONE-HALF.

(*Cornhill, Section 7 to Section 9, 2-track; completed.*)

National Contracting Co.	$18,583 53	
A. & P. Roberts Co.	637 98	
Construction	1,629 87	
Field supplies	463 24	
Teaming	145 70	
Labor	875 60	
Re-locating pipes	231 61	
Electric conduits	46 51	
Water-pipes	811 10	
Total		23,425 14

SECTION NINE.

(*Adams square, Washington street to Hanover street, 3-track, and station; completed.*)

Richardson & Young	$46,666 17	
A. & P. Roberts Co.	10,054 88	
Charles Brigham	750 00	
Hallstead & McNaugher	90 90	
Woodbury & Leighton	12,500 00	
Construction	13,567 27	
Advertising	11 26	
Office supplies	127 00	
Field supplies	8,164 01	
Stationery and printing	52 88	
Teaming	699 73	
Labor	5,378 23	
Re-locating pipes	113 09	
Electric conduits	3,924 67	
Rental	80 00	
Fuel and light	43 79	
Water-pipes	229 79	
Total		102,453 67
Carried forward,		$655,742 37

Brought forward,		$655,742 37

SECTION TEN.

(*Washington street, Hanover street to Haymarket square, 4-track, and station at Haymarket square; completed.*)

Schailer & Schniglau Co.	$3,806 21	
Carnegie Steel Co. (Ltd.)	3,909 43	
Hallstead & McNaugher	4 78	
Construction	14,191 33	
Legal and expert advice	3 00	
Office supplies	20	
Field supplies	2,917 96	
Teaming	367 94	
Labor	6,750 92	
Electric conduits	1,042 16	
Water-pipes	19 20	
Total		* 33,003 63

SECTION ELEVEN.

(*Haymarket square to Travers street, 4-track, and incline; completed.*)

Charles Linehan	$77,628 46	
New Jersey Steel and Iron Co.	12,313 20	
Hallstead & McNaugher	103 34	
Construction	4,930 27	
Advertising	271 23	
Office supplies	9 72	
Field supplies	1,472 73	
Stationery and printing	184 95	
Teaming	642 47	
Labor	3,380 82	
Rental	25 00	
Total		100,962 19

EAST BOSTON TUNNEL.

Stenographer	$49 44	
Skilled service	6,272 60	
Teaming	75 90	
Office supplies	20 84	
Field supplies	378 38	
Instruments	57 80	
Advertising	27 63	
Labor	812 45	
Total		7,695 04

ALTERATIONS.

General		121 59

SECTION THREE.

Skilled service	$205 95	
Labor	257 96	
Carried forward,	$463 91	$797,524 82

* $33,013.13 less $9.50 transferred to Section 3 account.

Brought forward,	$463 91	$797,524 82
Construction	1,902 90	
Teaming	18 21	
Field supplies	6 05	
Total		2,391 07

SECTION FIVE.

Skilled service	28 54

SECTION SEVEN.

Easterly platform:		
George W. Judd	$22,330 30	
Pennsylvania Steel Co.	6,859 52	
John S. Jacobs & Son	6,724 48	
Norcross Bros.	5,043 33	
Hallsted & McNaugher	96 65	
Labor	4,202 51	
Skilled service	5,589 35	
Field supplies	2,406 30	
Office supplies	100 26	
Instruments	1 20	
Legal and expert advice	450 00	
Stationery and printing	156 98	
Advertising	70 26	
Teaming	233 89	
Construction	3,473 74	
Re-locating pipes	178 67	
Rental	50 00	
Stenographer	19 00	
Messenger	1 00	
Water-pipes	84 76	
Total		58,072 20
Grade changes, Hanover street:		
Construction	$766 89	
Field supplies	187 62	
Labor	1,994 07	
Skilled service	9 55	
Teaming	215 70	
Total		3,173 83

SECTION NINE.

Labor	3 00

SECTION TEN.

Labor	$381 05	
Skilled service	4 78	
Construction	30 50	
Field supplies	18 40	
Teaming	4 65	
Total		439 38
Carried forward,		$861,632 84

Brought forward,		$861,632 84

INTEREST.

Paid by City Treasurer	$157,955 00	
Credits: Rentals received for use of subway,	74,164 40	
		83,790 60

CHARLESTOWN BRIDGE.

General Expenses: 1-5 to bridge	$8,118 93	
Perkins & White (Pier Contract)	88,995 62	
" " (Fender Contract)	3,345 81	
" " (Abutments)	32,184 38	
" " (Draw Foundation)	44,047 43	
Hallsted & McNaugher	984 82	
Dennis F. O'Connell, Charlestown approach	49,241 32	
A. & P. Roberts Co.	75,483 53	
D. J. Kiley & Co.	5,140 80	
Land damages	7,348 00	
Stationery and printing	668 87	
Instruments	26 39	
Construction	7,303 95	
Office supplies	150 51	
Field supplies	2,584 27	
Advertising	572 52	
Labor	417 11	
Legal and expert advice	1,617 50	
Teaming	8 00	
William Jackson	2,167 00	
Skilled service	17,851 24	
Total		348,258 00
Grand total		$1,293,681 44

SUMMARY.

	From beginning of work to Aug. 15, 1897.	Aug. 15, 1897, to Aug. 15, 1898.	Total.
Subway. — Subway commission	$14,131 16		$14,131 16
4-5 General Expenses	84,838 41	$32,475 73	117,314 14
Engineering Expenses	244,261 02	71,072 89	315,333 91
Miscellaneous	54,325 64	11,343 56	65,669 20
Section One	231,326 14	8,837 08	240,163 22
Two	329,559 01	31,730 98	361,289 99
Three	253,712 90	52,458 77	306,171 67
Three and one-half	9,452 49	19 50	9,471 99
Four	415,135 10	31,621 21	446,756 31
Five	244,534 66	140,703 88	385,238 54
Six	308,046 02	17,496 87	325,542 89
Seven	89,983 14	126,941 33	216,924 47
Eight	94,811 13	5,161 76	99,972 89
Eight and one-half	50,961 90	23,425 14	74,387 04
Nine	181,839 69	102,453 67	284,293 36
Ten	219,238 95	33,003 63	252,242 58
Eleven	757,891 02	100,962 19	858,853 21
Interest	133,334 69	83,790 60	217,125 29
Total	$3,717,383 07	$873,498 79	$4,590,881 86

Alterations. — General		$121 59	$121 59
Section Three		2,391 07	2,391 07
Five		28 54	28 54
Seven		61,246 03	61,246 03
Nine		3 00	3 00
Ten		439 38	439 38
Total		$64,229 61	$64,229 61
Subway Total	$3,717,383 07	$937,728 40	$4,655,111 47
East Boston Tunnel	$1,129 44	$7,695 04	$8,824 48
Bridge. — 1–5 General Expenses	$21,209 60	$8,118 93	$29,328 53
Engineering Expenses	303,591 36	340,139 07	643,730 43
Total	$324,800 96	$348,258 00	$673,058 96
Grand Total	$4,043,313 47	$1,293,681 44	$5,336,994 91

The reports of the Chief Engineer and of the Chief Engineer for Charlestown Bridge are appended.

The term of office of the Commission will expire on the second of July, 1899. The subway is already completed. It is expected that the bridge to Charlestown, which the Commission was required by the original act to construct, will be finished before said date. There may, however, at that time still be outstanding claims on these accounts. To provide for defence against such claims and for their payment in case the decision of the Court is adverse, and for the construction of the East Boston tunnel, of the alterations in the subway, and of the additional subways called for by the Act of 1897, before referred to, further administrative agency must be created by legislation.

GEORGE G. CROCKER,
CHARLES H. DALTON,
THOMAS J. GARGAN,
GEORGE F. SWAIN,
HORACE G. ALLEN,
Boston Transit Commission.

REPORT OF THE CHIEF ENGINEER.

BOSTON, Aug. 16, 1898.

GEORGE G. CROCKER, CHARLES H. DALTON, THOMAS J. GARGAN, GEORGE F. SWAIN, HORACE G. ALLEN, *Boston Transit Commissioners:*

The following report, in accordance with your request, is intended to contain a brief statement of the principal facts relating to the construction of the subway. Most of the statistics as to contractors, dates, structures, excavation, etc., are given in the Condensed Statement by Contract Sections on pages 37 to 57, inclusive, and (except those relating to the year ending Aug. 15, 1898) are taken from the three reports already published. This Condensed Statement is followed by remarks under appropriate headings concerning surveys, studies, methods employed, cross-sections, etc., some of which are also taken (with little change of phraseology) from the three reports already published. Some of the pictorial illustrations contained in the present report are similar to those that have appeared before, but they embody corrections. More detailed information in regard to changes in pipes and sewers, cement, equipment of the subway, canvasses of bids, etc., is given in Appendices A to U, inclusive.

PROGRESS.

Construction was begun in the Public Garden, March 28, 1895. The Condensed Statement by Contract Sections concerning work on the subway, beginning on page 37, together with the general map of the subway which precedes this report, shows the progress from that time to the substantial completion of the subway at its northerly end, July 5, 1898. As far as construction was concerned, it could have been built much more rapidly. Much time was required in determining the routes and character of the structures, especially at the northerly end.

The following paragraphs refer to work that has been done during the year ending Aug. 15, 1898, and is not elsewhere alluded to:

The walls of the stations north of Park street have been lined with enamelled tile, and artificial stone platforms have been made in these stations.

The interior of the walls of the subway north of Park street has been whitened with a lime wash.



BOSTON TRANSIT COMMISSION

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 1.--STOPPING-PLACE FOR CARS AT TOP OF INCLINE, PUBLIC GARDEN.

PLATE 1

Considerable study has been given to the question of the East Boston tunnel, and additional surveys have been made. Some of the lines considered are indicated on Plate 37.

CONDENSED STATEMENT BY CONTRACT SECTIONS CONCERNING WORK ON THE SUBWAY (INCLUDING WORK DONE DIRECTLY BY THE COMMISSION) FROM MARCH 28, 1895, TO AUG. 15, 1898.

Where nothing is said to the contrary, in the description which follows, the work was all performed prior to Aug. 15, 1897. The work performed during the year ending Aug. 15, 1898, is treated at greater length than that performed before, as the earlier work has been fully described in preceding reports. The position and extent of the several sections are shown on the general map at the beginning of this report.

Work done on **Section 1** of the Subway (Contract Work).

Contractors for Steel Work. — The Pennsylvania Steel Co., Steelton, Penn.
Contractors for Construction. — Jones & Meehan, Jamaica Plain, Mass.
Assistant Engineer on the Ground (City Assistant). — F. B. Edwards.

	Date of Contract.	Final certificate given (respectively of substantial completion of delivery of steel work or of substantial completion of construction).
Steel work . .	Mar. 23, 1895.	Oct. 21, 1895.
Construction . .	Mar. 23, 1895.	May 22, 1896.

General Description of Structures. — There is an open incline with granite side-walls for two tracks in Public Garden, 685 feet of 2-track subway from portal to point in Boylston-street mall of the Common nearly opposite old Public Library, and 408 feet of 4-track subway in Tremont-street mall of the Common from about 170 feet north of Mason street to near West street. The subway is of steel and masonry combined type. Section 1 is illustrated by Plates 1, 7, and 29.

Character of Excavation. — Incline : excavation was ashes, sand, gravel, and oyster shells for the first 11 feet from the surface; below was fibrous peat. The excavation for the 2-track subway west of Charles street was similar to that for the incline; for the 2-track subway east of Charles street the excavation was in sand and gravel; for the 4-track subway the excavation was loam, gravel, and oyster shells for the first 3 feet from the surface, and then mainly sand.

Section 1. Water was encountered in troublesome quantities near Charles street.

Method of doing Work. — Excavation by open cut in the Common and Public Garden.

Force employed by Contractor on Construction. — The force varied considerably, but during the period of greatest activity was about 150 men and 15 teams.

WORK DONE ON **Section 2** OF THE SUBWAY (CONTRACT WORK).

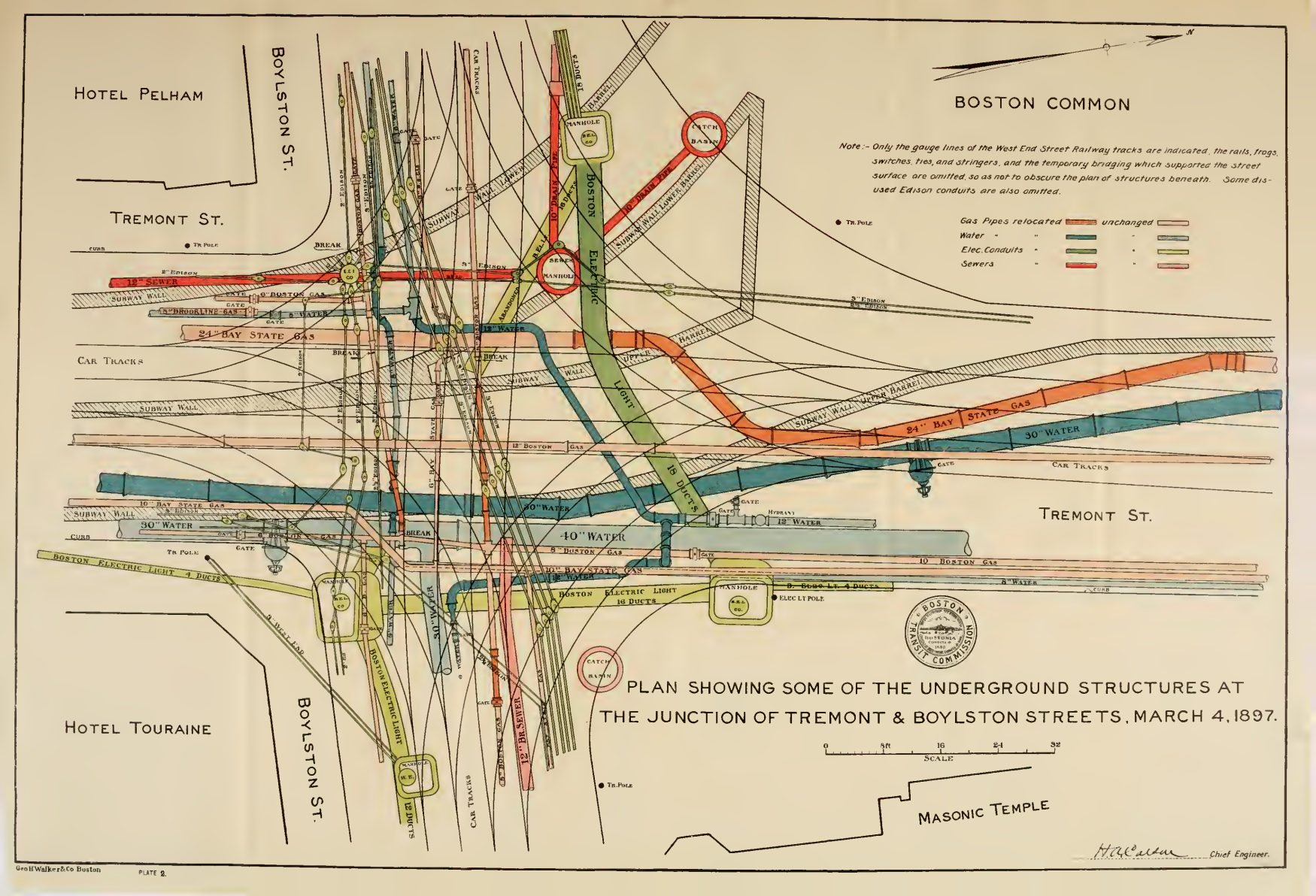
Contractors for Steel Work. — THE PENNSYLVANIA STEEL CO., Steelton, Penn.
Contractor for Construction. — EDWARD W. EVERSON, Providence, R.I.
Assistant Engineer on the Ground (City Assistant). — FRANK C. SHEPHERD.

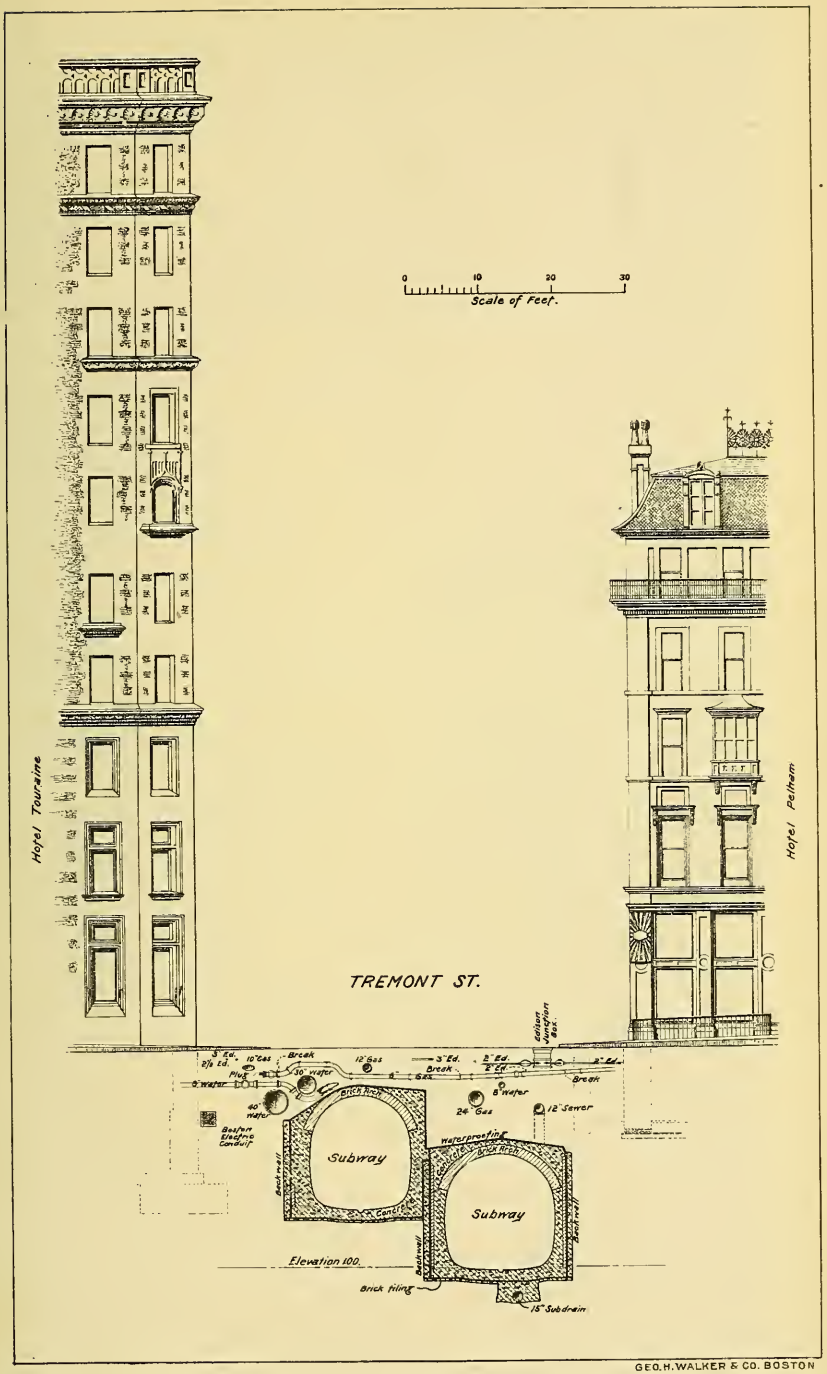
Buildings over Stairways. — For a statement concerning them see page 64.

	Date of Contract.	Final certificate given (respectively of substantial completion of delivery of steel work or of substantial completion of construction).
Steel work . .	Sept. 13, 1895.	June 11, 1896.
Construction . .	Sept. 20, 1895.	Nov. 28, 1896.

General Description of Structures. — The Boylston-street station contains four tracks and 2 island platforms of artificial stone, and two stairways lead from the surface to each platform. The structure is of the steel and masonry combined type. The walls are lined with enamelled brick. The westerly track (going southerly on Tremont street) begins at the southerly end of the south-bound platform to descend with an 8 per cent. grade, passes by curve under the two Boylston-street tracks, and there begins to ascend at a 4½ per cent. grade. There is a subpassage 6 feet wide and about 7 feet high, with a stairway at each end connecting the north-bound and south-bound platforms. A conduit of concrete and brickwork having an internal diameter of about 10 feet was built under the station, running diagonally across from Tremont street near the Tremont Theatre, for a 30-in. and a 40-in. water-pipe. The conduit terminates on each side of the subway in a chamber about 10 feet wide and 18 feet long. These chambers were built under a special contract. For plan of this station see Plate 8.

Character of Excavation. — The upper 4 feet of excavation consisted of surfacing and loam. Below this to grade was found gravel and sand of various degrees of fineness. After leaving the deep excavation for the sub-subway at Boylston street, little ground water was met with in the trenches.


HOTEL PELHAM
BOYLSTON ST.
TREMONT ST.
BOSTON COMMON
HOTEL TOURAINE
BOYLSTON ST.
MASONIC TEMPLE
Note:- Only the gauge lines of the West End Street Railway tracks are indicated, the rails, frogs, switches, ties, and stringers, and the temporary bridging which supported the street surface are omitted, so as not to obscure the plan of structures beneath. Some disused Edison conduits are also omitted.
Gas Pipes relocated unchanged
Water " "
Elec. Conduits " "
Sewers " "
Tr. Pole
12" SEWER
24" BAY STATE GAS
30" WATER
40" WATER
12" WATER
8" WATER
6" BOSTON GAS
8" BOSTON GAS
10" BOSTON GAS
12" BOSTON GAS
10" BAY STATE GAS
12" BAY STATE GAS
BOSTON ELECTRIC LIGHT 4 DUCTS
BOSTON ELECTRIC LIGHT 16 DUCTS
BOSTON ELECTRIC LIGHT
15 DUCTS
12" BR. SEWER
10" DRAIN PIPE
CAR TRACKS
SUBWAY WALL
SUBWAY WALL LOWER BARREL
MANHOLE
CATCH BASIN
HYDRANT
ELEC LT POLE
SCALE
0 8ft 16 24 32
PLAN SHOWING SOME OF THE UNDERGROUND STRUCTURES AT THE JUNCTION OF TREMONT & BOYLSTON STREETS, MARCH 4, 1897.
BOSTON TRANSIT COMMISSION
H.A. Carson Chief Engineer.
Geo H. Walker & Co Boston
PLATE 2.



GEO. H. WALKER & CO. BOSTON

PLATE 3. CROSS SECTION ABOUT 17 FEET NORTH OF SOUTHERLY LINE OF BOYLSTON STREET.

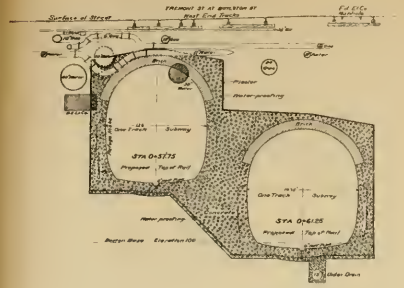


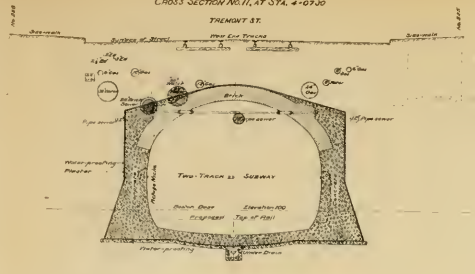
BOSTON TRANSIT COMMISSION

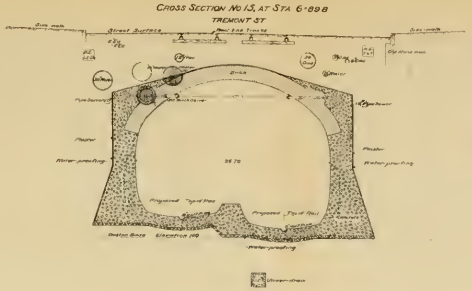
THE HELIOTYPE PRINTING CO., BOSTON

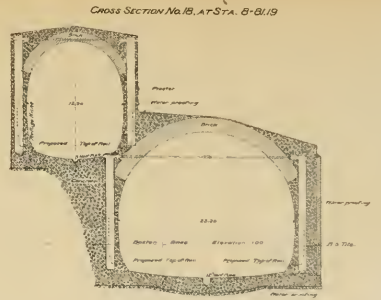
SECTION 4.--BELLMOUTH NEAR VAN RENSSELAER PLACE, TREMONT STREET (LOOKING NORTH). SEPT. 27, 1897.

PLATE 4.





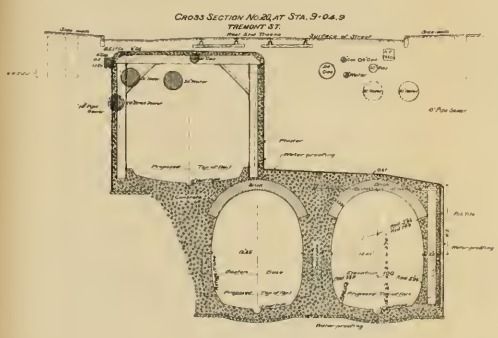


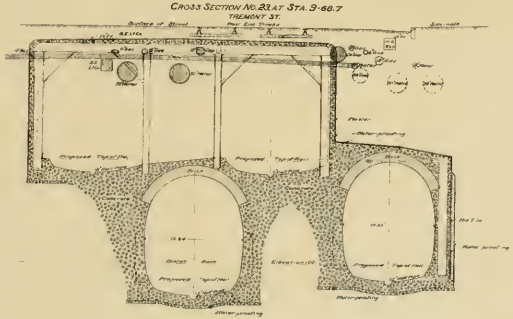


CROSS SECTIONS SECTION 4, SUBWAY.

Scale

K.F. Cutter Chief Engineer





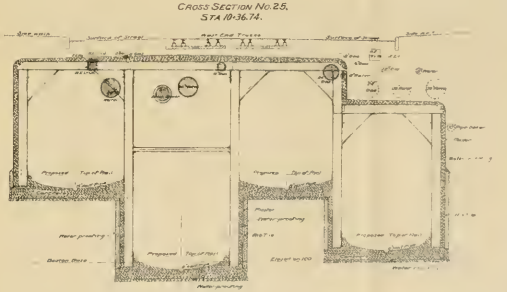


PLATE 5





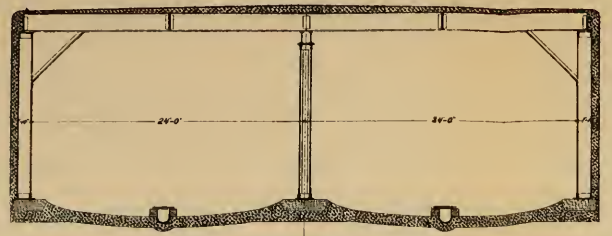


BOSTON TRANSIT COMMISSION

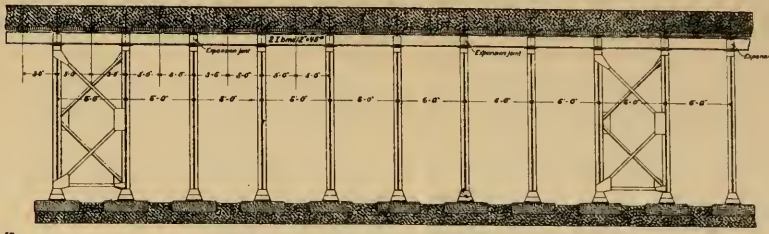
THE HELIOTYPE PRINTING CO., BOSTON

SECTION 4.--BELLMOUTHS, FOUR-TRACKS AND SUB-SUBWAY UNDER TREMONT STREET, NEAR HOLLIS STREET (LOOKING SOUTH).

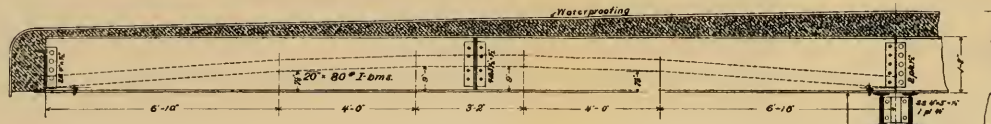
PLATE 6.



General Cross Section for 410 lin ft.



General Longitudinal Section at Center



NOTES

Columns to be faced square at both ends after knees are riveted to them, to insure contact with horizontal plates.

Rivets to be $\frac{7}{8}$" in. diameter in walls and roof beams and $\frac{3}{4}$" in. centre columns and longitudinal beams.

Rivets shown solid to be field driven.

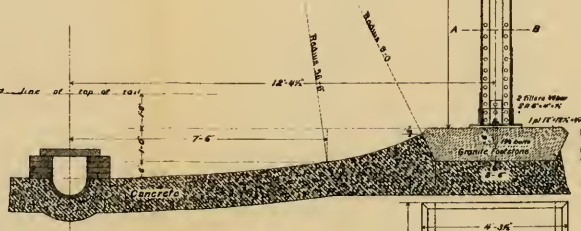
Slotted holes to be $\frac{13}{16}$" x $1\frac{7}{16}$" to be filled with $\frac{15}{16}$" turned bolts.

Where Subway is on a grade, columns and roof beams are to be kept vertical; the necessary variations being made in the end channels, bridging and bracing. Where necessary use tapered shims between channels and posts; also above and below longitudinal beams.

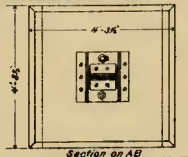
Bricks in drain to be laid headers; each course to be thinly plastered after laying: side joints to be without mortar.



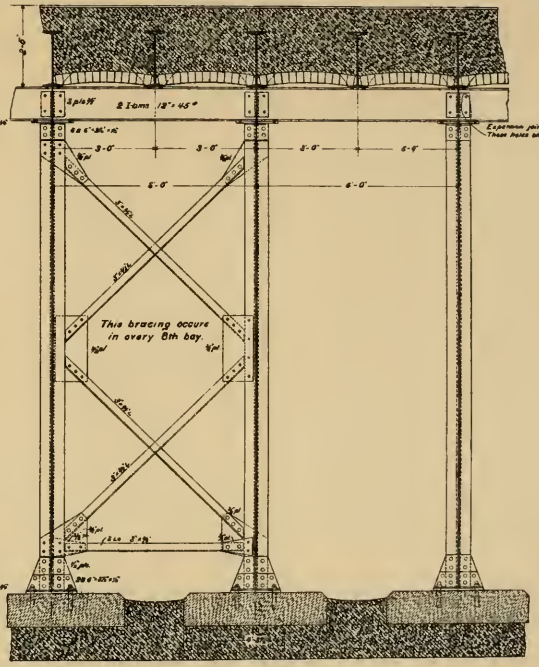
Longitudinal section showing under-drain.



Details of Cross Section



Section on AB



Details of Longitudinal Section

REGULAR FOUR TRACK SUBWAY

Scale of Details

CONTRACT PLAN SECTION 1, SUBWAY.

BOSTON TRANSIT COMMISSION

February, 1895

K. A. Carlson Chief Engineer.

PLATE 7.

GEO. H. WALKER & CO. LITH. BOSTON



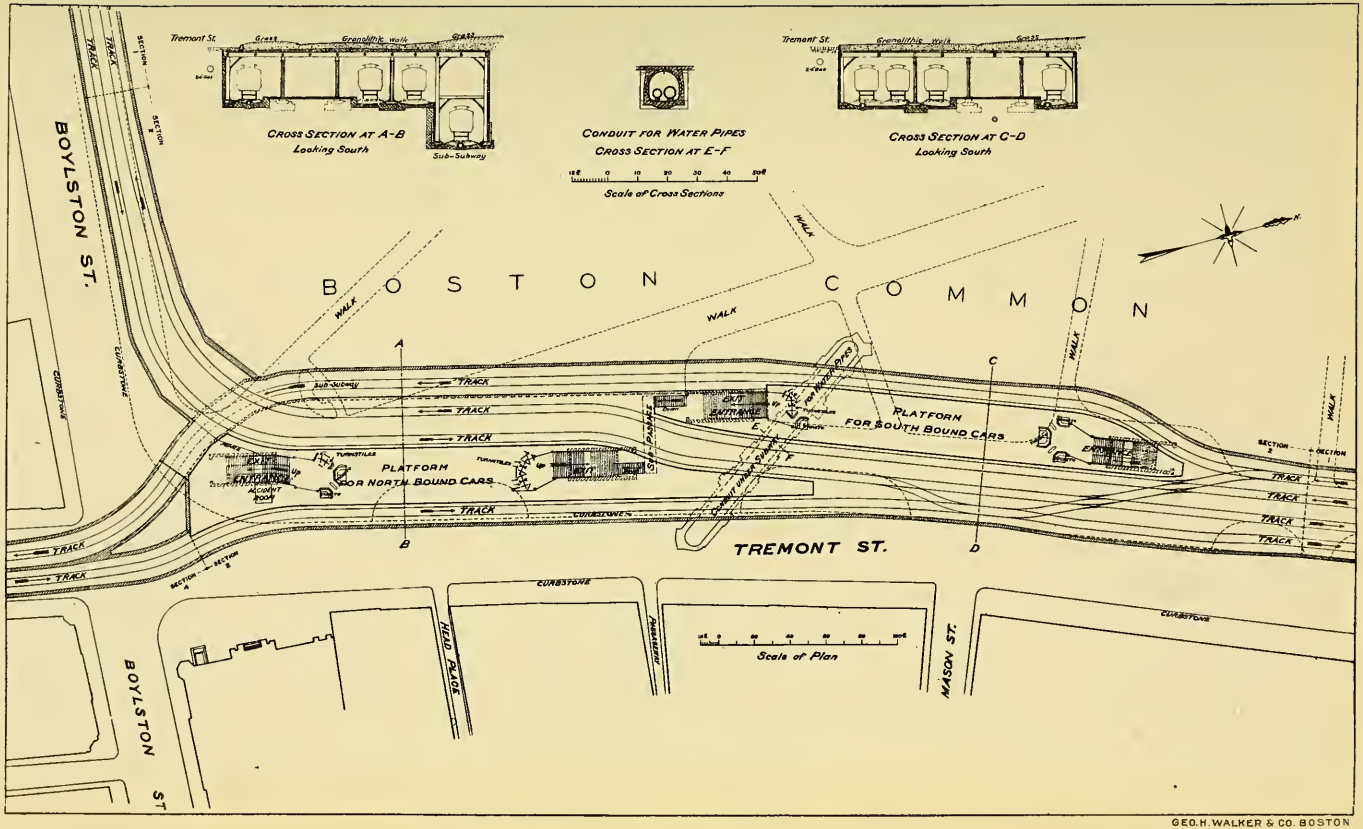


PLATE 8. PLAN OF BOYLSTON STREET STATION.



BOSTON TRANSIT COMMISSION

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 3.--PARK-STREET STATION STAIRWAY BUILDINGS (LOOKING SOUTH). SEPT. 1, 1897.

PLATE 9.

Method of doing Work. — The excavation was by open cut (in the Common). Operations were carried on principally by 3 machines and a narrow-gauge steam train. The first of these machines (2 steam derricks with booms about 60 feet long) hoisted out earth. The second separated and prepared the sand and gravel and then mixed them with cement and water to make concrete. The third machine (similar to the first) was used to put the concrete into place and set footing-stones and steelwork. The train carried away the surplus earth. Section 2.

Force employed by Contractor on Construction. — This ordinarily consisted of 150 men and 3 teams.

Work done on **Section 3** of the Subway (Contract Work).

Contractors for Steel Work. — The Pennsylvania Steel Company, Steelton, Penn.
Contractor for Construction. — Frederic E. Shaw, Providence, R.I.
Assistant Engineer on the Ground (City Assistant). — P. F. O'Brien.

Buildings over Stairways. — These are illustrated by Plate 9. For a statement concerning them see page 64.

	Date of Contract.	Final certificate given (respectively of substantial completion of delivery of steel work or of substantial completion of construction).
Steel work . .	Oct. 25, 1895.	June 22, 1896.
Construction . .	Oct. 21, 1895.	Mar. 10, 1897.

General Description of Structures. — The Park-street station contains four tracks and 2 island platforms of artificial stone. The structure is of the steel and masonry combined type, with walls lined with enamelled tile. The two inner tracks terminate in a loop at the northern end of the station, which enables cars using these tracks, for example, the Brookline and Brighton cars, to return without switching. Space is provided within the loop for tracks where extra or disabled cars can stand. Pits are provided under these tracks to enable the motors to be taken out or other repairs to be made. For plan see Plate 10. The interior of the station is illustrated by Plates 11 and 12.

Character of Excavation. — At Park street the excavated earth was mainly uniform clay and gravel, with a stratum one or two feet thick of very fine sand in the middle of its depth. Towards the southerly end of the station the excavation was mainly of a sandy character and contained a small summit of clay. The material was such as to allow nearly vertical banks to stand for a long time without sheeting, but great care was necessarily exercised in bracing in

Section 3. the vicinity of Park-street church. The volume of water seeking to enter the trench was small in amount, but was enough to cause some annoyance.

Method of doing Work. — The excavation was by open cut, most of the section being in the Common. Most of the earth was thrown into carts which ascended from the pit on an inclined roadway. Comparatively little timber for sustaining the banks was found necessary.

Force employed by Contractor on Construction. — No night-work was done except during October and November, 1896, when two 10-hour shifts were worked in order to hasten progress on excavation in Tremont and Park streets. The average force employed was about 100 men working one shift of 10 hours with 10 double teams.

SECTION 3½.

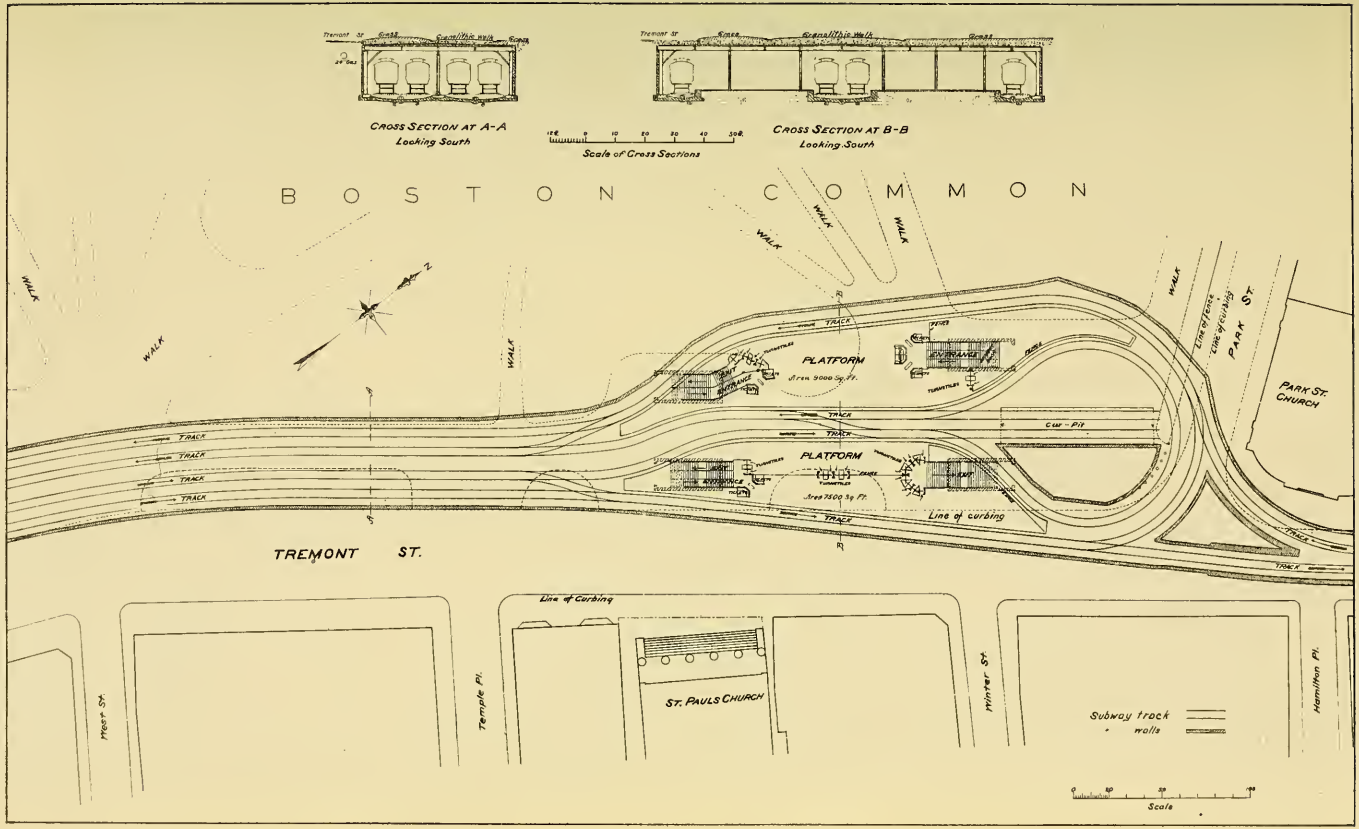
Contractor for Steel Work. — BOSTON BRIDGE WORKS, Boston.
Contractor for Construction. — EDWARD W. EVERSON, Providence, R.I.

	Date of Contract.	Date of substantial completion (respectively of delivery of steel work or of construction).
Steel work . . .	Nov. 6, 1895.	Nov. 16, 1895.
Construction . .	Nov. 7, 1895.	Dec. 28, 1895.

The section known as 3½ consists of two single-track subways at the foot of Park street, connecting Section 3 with Section 6. It was necessary to change the position of the sewer in Park street to remove it from the space to be occupied by the subway structure, and as it would necessarily, in its changed position, pass over the location for the subway it was thought best to build these portions underneath at the time when the sewer change was made. Each of the subways has concrete sidewalls and a brick arch backed with concrete. In the contract for this section were included the two pieces of single-track subway alluded to above and about 365 linear feet of pipe sewer with 3 manholes and 4 catch-basins.

WORK DONE ON **Section 4** OF THE SUBWAY (CONTRACT WORK AND WORK DONE DIRECTLY BY THE COMMISSION) TO AUG. 15, 1897.

Contractors for Steel Work. — NEW JERSEY STEEL AND IRON COMPANY, Trenton, N.J.
Contractors for Construction. — METROPOLITAN CONSTRUCTION COMPANY, Boston, Mass.
Assistant Engineer on the Ground (City Assistant). — F. B. EDWARDS.



GEO. H. WALKER & CO. BOSTON

PLATE **10.** PLAN OF PARK STREET STATION.



BOSTON TRANSIT COMMISSION

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 3.--PARK-STREET STATION, SOUTH-BOUND PLATFORM (LOOKING SOUTH).

PLATE 11.



BOSTON TRANSIT COMMISSION

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 3.--SOUTH-BOUND PLATFORM, PARK-STREET STATION (LOOKING NORTH).

PLATE 12.

Section 4.

	Date of Contract.	Final certificate given (respectively of substantial completion of delivery of steel work or of substantial completion of construction).
Steel work . .	Mar. 17, 1896.	June 22, 1896.
Construction . .	Mar. 21, 1896.	Apr. 1, 1897.

General Description of Structure. — The structure consists in part of two separate single-track subways under Boylston street connecting with the Boylston-street station. The bottom of the masonry for the westerly one is about 39 feet below the surface, where it leaves the Boylston-street station. This depth, 13.5 feet below the level of the easterly section at the same point, is necessary to allow the Tremont-street south-bound cars to pass under the Boylston-street subway. The two single tracks converge opposite the Hotel Pelham and form a double-barrel arch, which is continued in Tremont street to a point about 30 feet south of Van Rensselaer place, near which point the difference in level between the easterly and westerly tracks ceases. From near Van Rensselaer place to near the southerly side of Seaver place the subway is a single wide-arch structure. At the southerly side of Seaver place the double-barrel arch again occurs and a renewed divergence of grade commences, for the purpose of allowing the Shawmut-avenue south-bound track to pass under the Tremont-street north-bound track near Common street. The southerly portion of Section 4 is a 4-track structure of the steel and masonry combined type. Illustrations of Section 4 are given in Plates 2, 3, 4, 5, and 6.

Character of Excavation. — At the westerly branch at north side of Boylston street fine sand prevailed throughout, with some water in the bottom. A considerable part of the excavation was in clay, mixed with fine sand. The preliminary tunnel under Section 4, alluded to below, driven directly by the Commission, dried the ground and rendered it firm and easy of excavation.

Method of doing Work. — The slice system was made use of. The surface was maintained except during a portion of the night-time.

Force employed by Contractor on Construction. — The force ordinarily employed was 100 men and 10 teams during the day, and 60 men and 9 teams at night, working 10-hour shifts.

Some of the Work done directly by the Commission or done by Minor Contract. — In order to determine the exact nature of the ground and to obtain the benefits of drainage, a tunnel was built directly by the Commission before the contract for Section 4 was let. The tunnel was about 3½ feet wide and 5 feet high and extended from Boylston street

Section 4. to about 20 feet south of Seaver place. Before the Contractor for Section 4 began construction, buildings numbered 285 to 291 and 280 to 284 Tremont street were underpinned by contract with Isaac Blair & Co. Two slices of two-track subway each about 12 feet long were built in order to demonstrate the feasibility of the slice method. This was done before the Contractor for Section 4 began construction.

Gas Explosion above the Subway at the junction of Boylston and Tremont streets. — An explosion of gas took place above the subway at the junction of Tremont and Boylston streets about noon, March 4, 1897. This is referred to in the Third Annual Report. Plates 2 and 3 show some of the underground structures at this locality.

WORK DONE ON **Section 4** OF THE SUBWAY DURING THE YEAR ENDING AUG. 15, 1898.

Ventilating Chamber in Sidewalk in front of Winthrop School Yard (done directly by Commission).

It was at first proposed to construct the outlet for the ventilating chamber in this locality within the school yard, but this question had not been determined at the time the contract was made for Section 4, and the ventilating chamber was not therefore included in the contract. It was finally decided to place the air outlet in the sidewalk. This outlet is 6 feet 8 inches by 40 feet, covered with steel gratings. The walls are of concrete and steel, the steel being mostly that used on Section 6 for temporary purposes. The chamber is designed for 2 fans, 7 feet diameter, separated by a concrete cross-wall. The chamber is partially roofed over with steel and concrete construction, and the vertical shaft has numerous louvres of concrete and steel which serve the double purpose of insuring a uniform discharge of air and of protecting the motors from rain and snow. Provision is made for draining into the centre drain of the subway. The work was begun July 19, 1897, was shut down from July 28 to August 16, and including all incidental work was finished October 22. Some of the quantities are as follows:

Earth excavation,	515 cubic yards.
Portland cement concrete,	203 " "
Waterproofing,	215 square yards.
Steel erected,	7 tons.

WORK DONE ON **Section 5** OF THE SUBWAY (CONTRACT WORK).

Contractors for Steel Work. — BOSTON BRIDGE WORKS, Boston.
Contractors for Construction. — W. H. KEYES & CO., Boston.
Assistant Engineer on the Ground. (City Assistant) — F. B. EDWARDS.

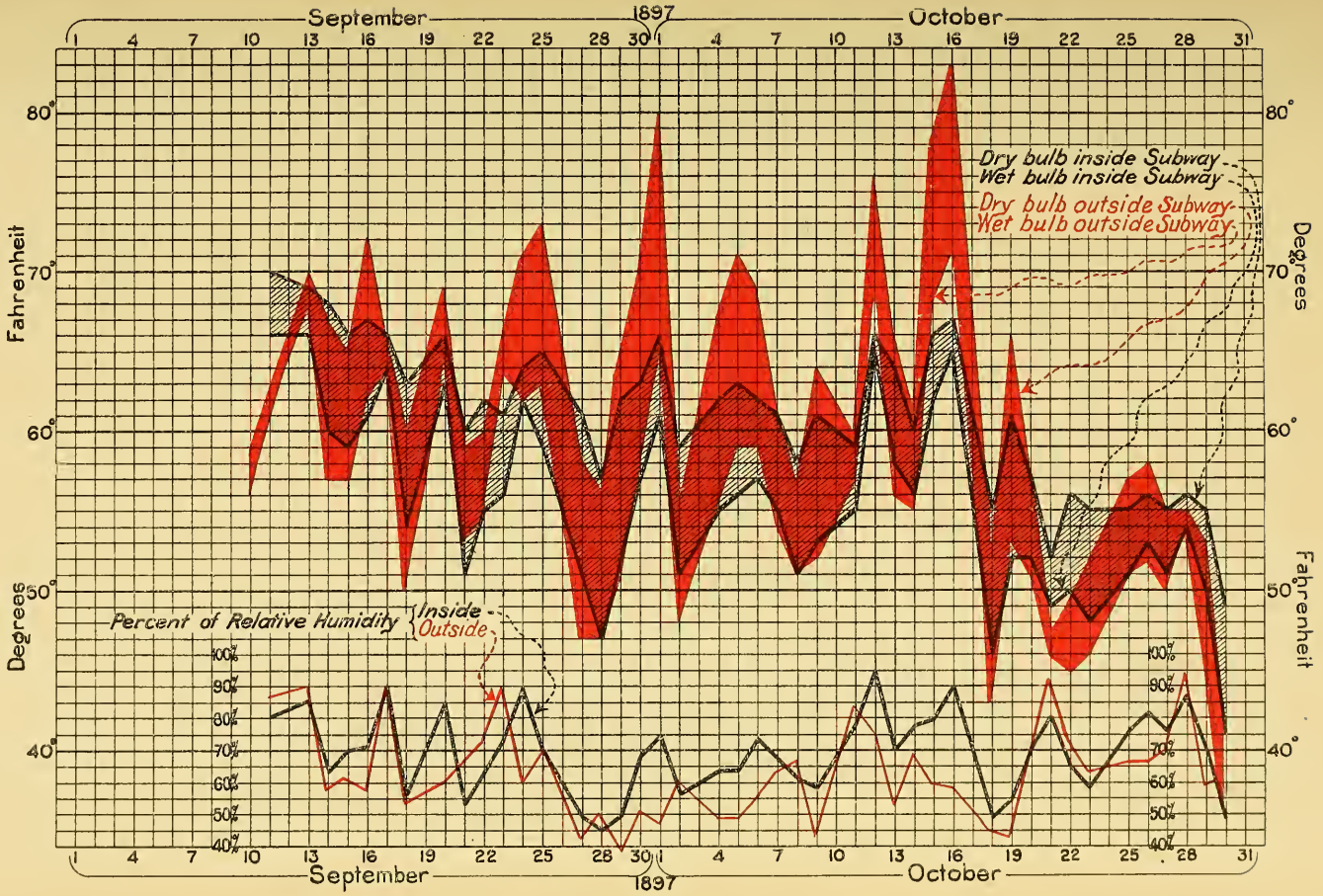


PLATE 13. TEMPERATURE AND RELATIVE HUMIDITY INSIDE AND OUTSIDE OF THE SUBWAY.

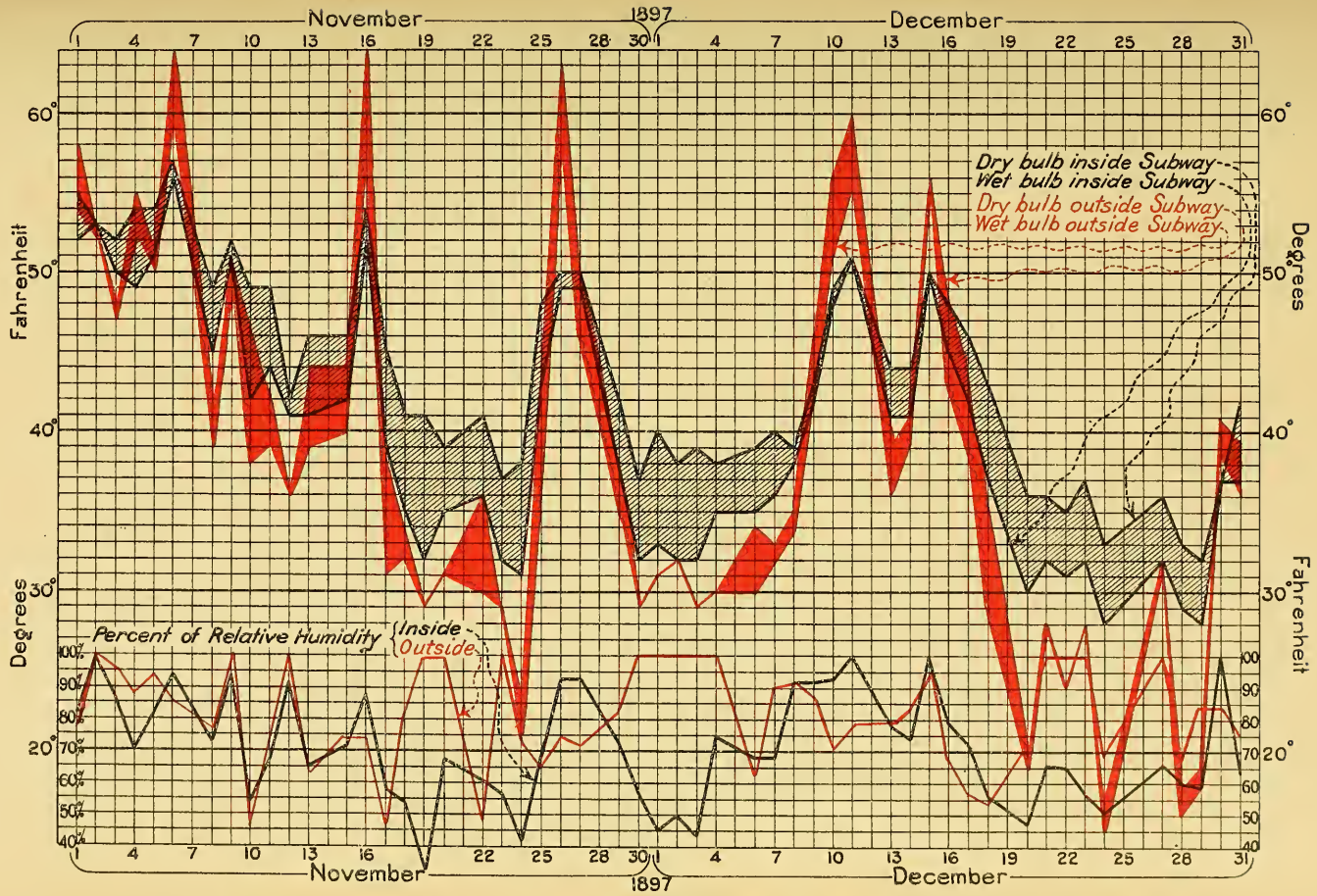


PLATE 13a TEMPERATURE AND RELATIVE HUMIDITY INSIDE AND OUTSIDE OF THE SUBWAY.

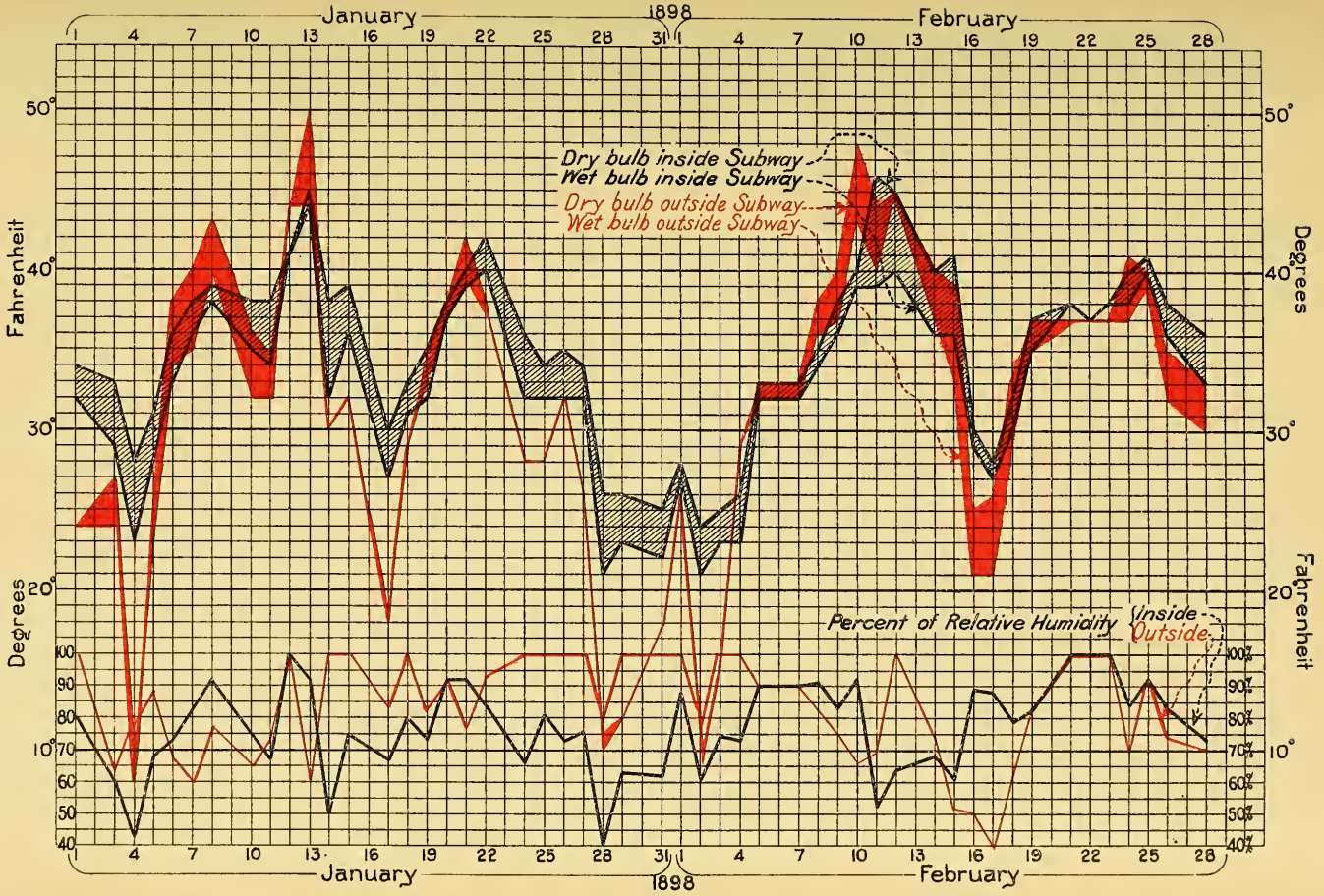


PLATE 13b TEMPERATURE AND RELATIVE HUMIDITY INSIDE AND OUTSIDE OF THE SUBWAY.

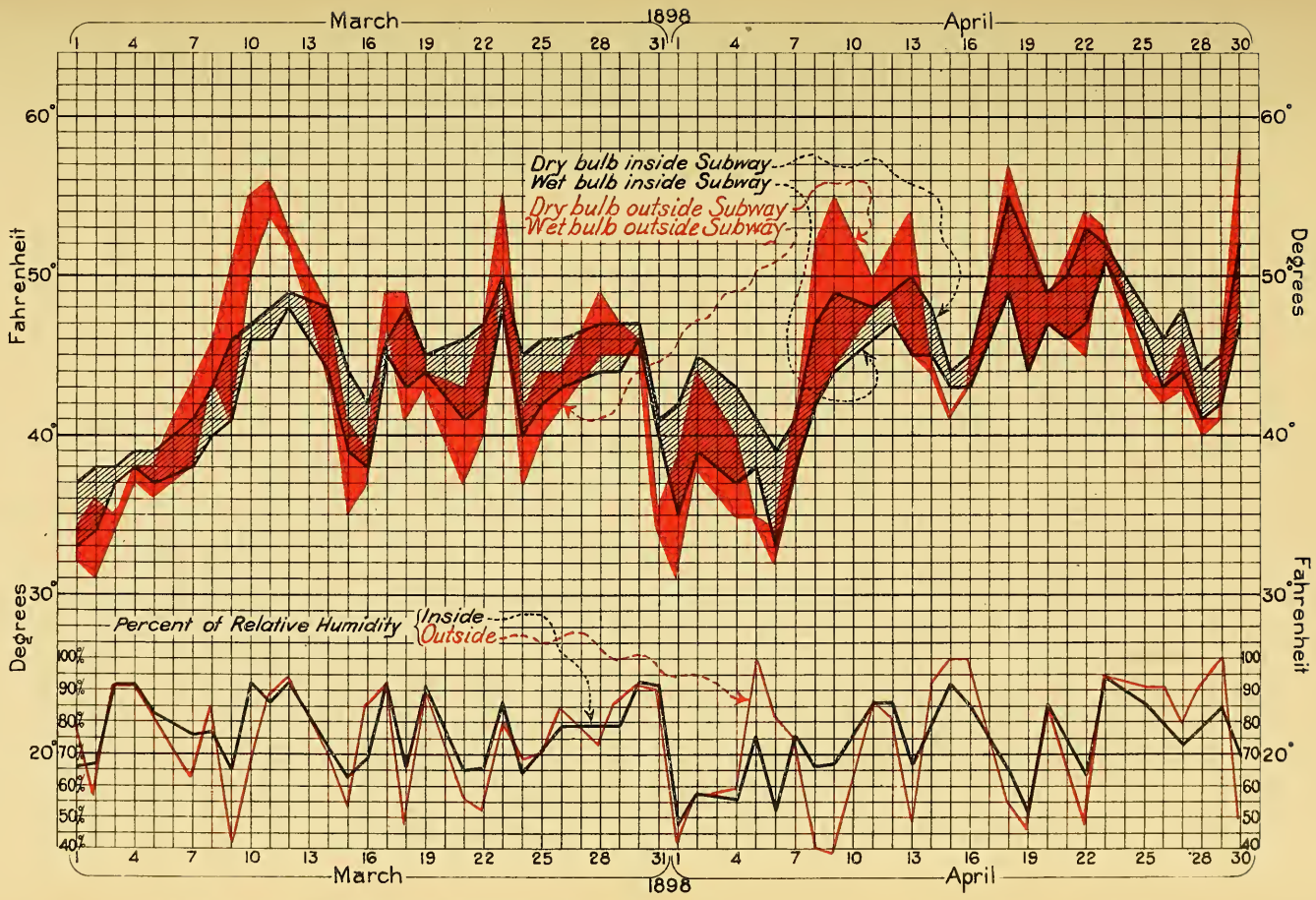


PLATE 13c TEMPERATURE AND RELATIVE HUMIDITY INSIDE AND OUTSIDE OF THE SUBWAY

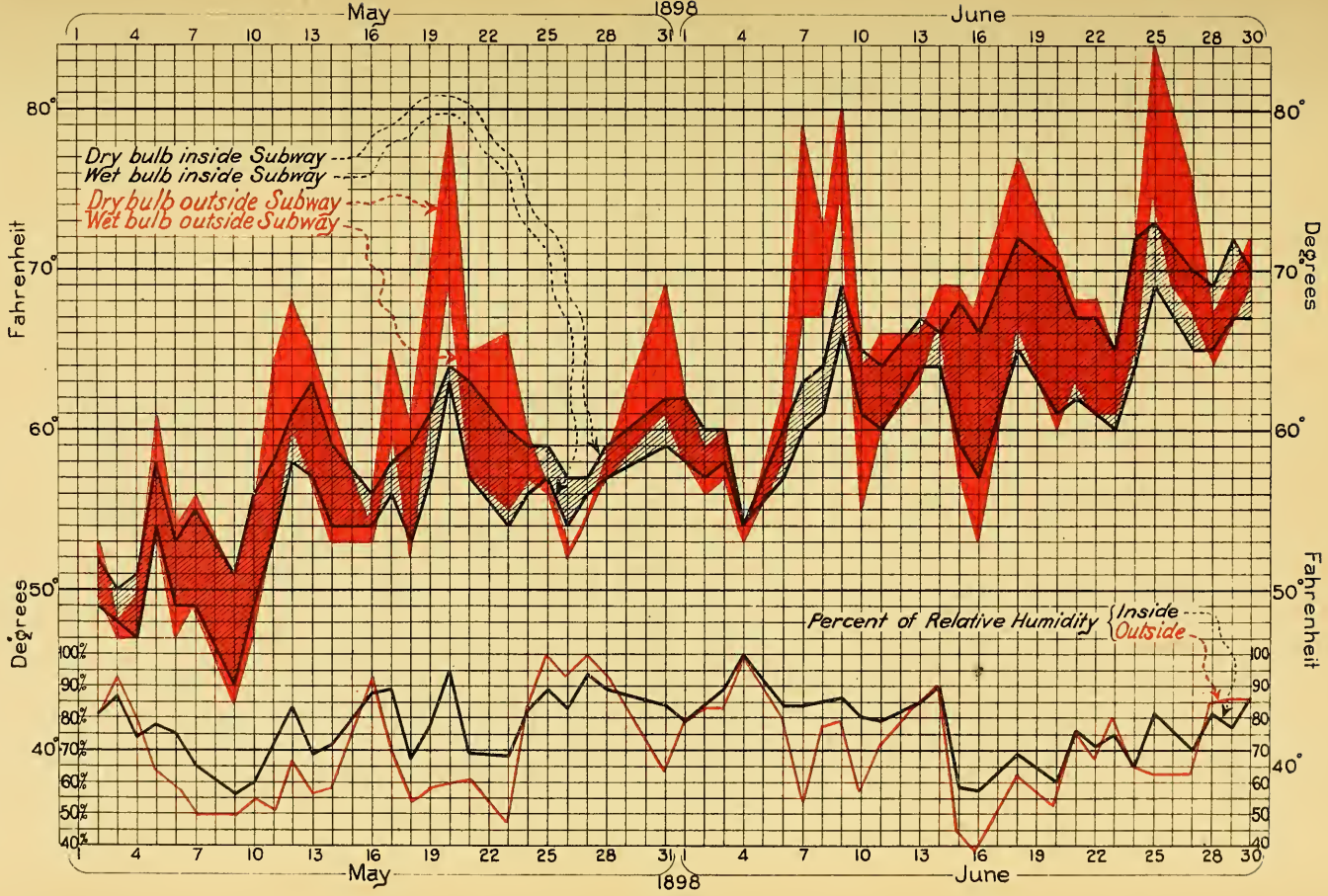


PLATE 13d TEMPERATURE AND RELATIVE HUMIDITY INSIDE AND OUTSIDE OF THE SUBWAY.

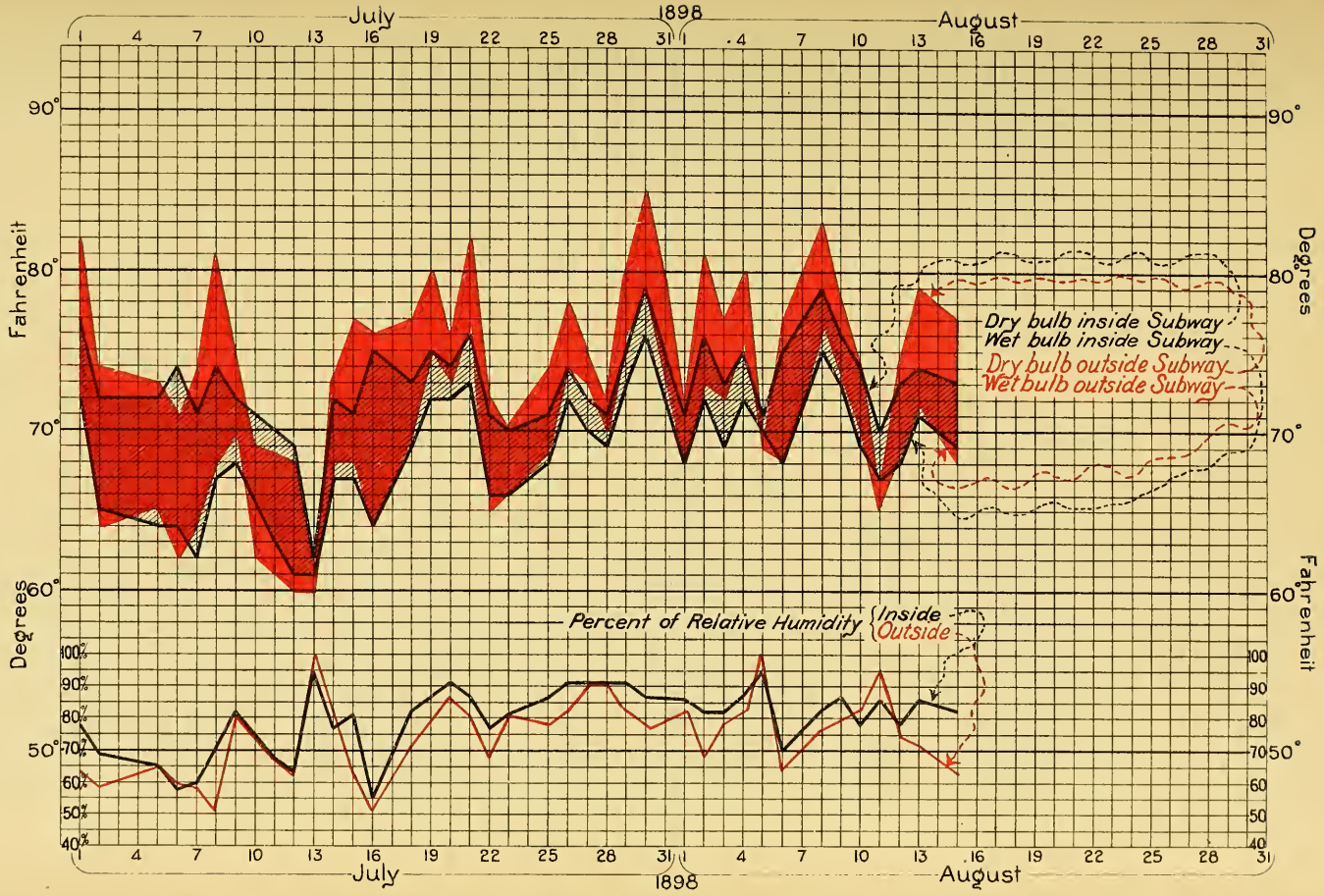


PLATE 13e TEMPERATURE AND RELATIVE HUMIDITY INSIDE AND OUTSIDE OF THE SUBWAY.

	Date of Contract.	Final certificate given (respectively of substantial completion of delivery of steel-work or of substantial completion of construction).	Section 5.
Steel work . .	Aug. 20, 1896.	Oct. 25, 1896	
Construction . .	Aug, 27, 1896.	Jan. 16, 1897	

General Description of Structure. — An open inclined approach reaches the surface at Pleasant street. The construction is such as to permit a building (say an apartment house) of 11 stories in height, of fireproof construction, to be built over the nearly triangular space included between Shawmut avenue and Tremont street and between Warrenton street and Pleasant street. The northerly part of the section is of the steel and masonry combined type.

Character of Excavation. — The excavation was chiefly blue clay. There was little water in the trench except surface water after rains.

Method of doing Work. — Open cut.

Force ordinarily employed by Contractor on Construction. — The force was ordinarily 18 during day and 15 at night. The work was carried on during 135 days and 75 nights.

Tearing down Buildings. — The buildings formerly on the site of this section were torn down and removed under a contract with A. A. Elston & Co.

Work done on **Section 6** of the Subway (Contract Work and Work done directly by the Commission).

Contractors for Steel Work. — Berlin Iron Bridge Co., East Berlin, Conn.

Contractors for Construction. — R. A. Malone & Co., Boston, Mass.

Assistant Engineer on the Ground (City Assistant). — H. H. Marden, Jr.

	Date of Contract.	Final certificate given (respectively of substantial completion of delivery of steel work or of substantial completion of construction).
Steel work . . .	May 4, 1896.	Aug. 12, 1896.
Construction . .	May 9, 1896.	Aug. 20, 1896.

General Description of Structure. — Most of the structure is of the wide-arch type, the only exception being a double-barrel from the bellmouth at the southerly end of the section. Cross-sections are given on Plates 15, 18, and 29.

Work done by contract and work done directly by the Commission. — Before the contract was let a slice was built by direct work near the Massachusetts Historical Building. The principal object of this was to determine to a greater extent than that shown by the borings the character of the softest

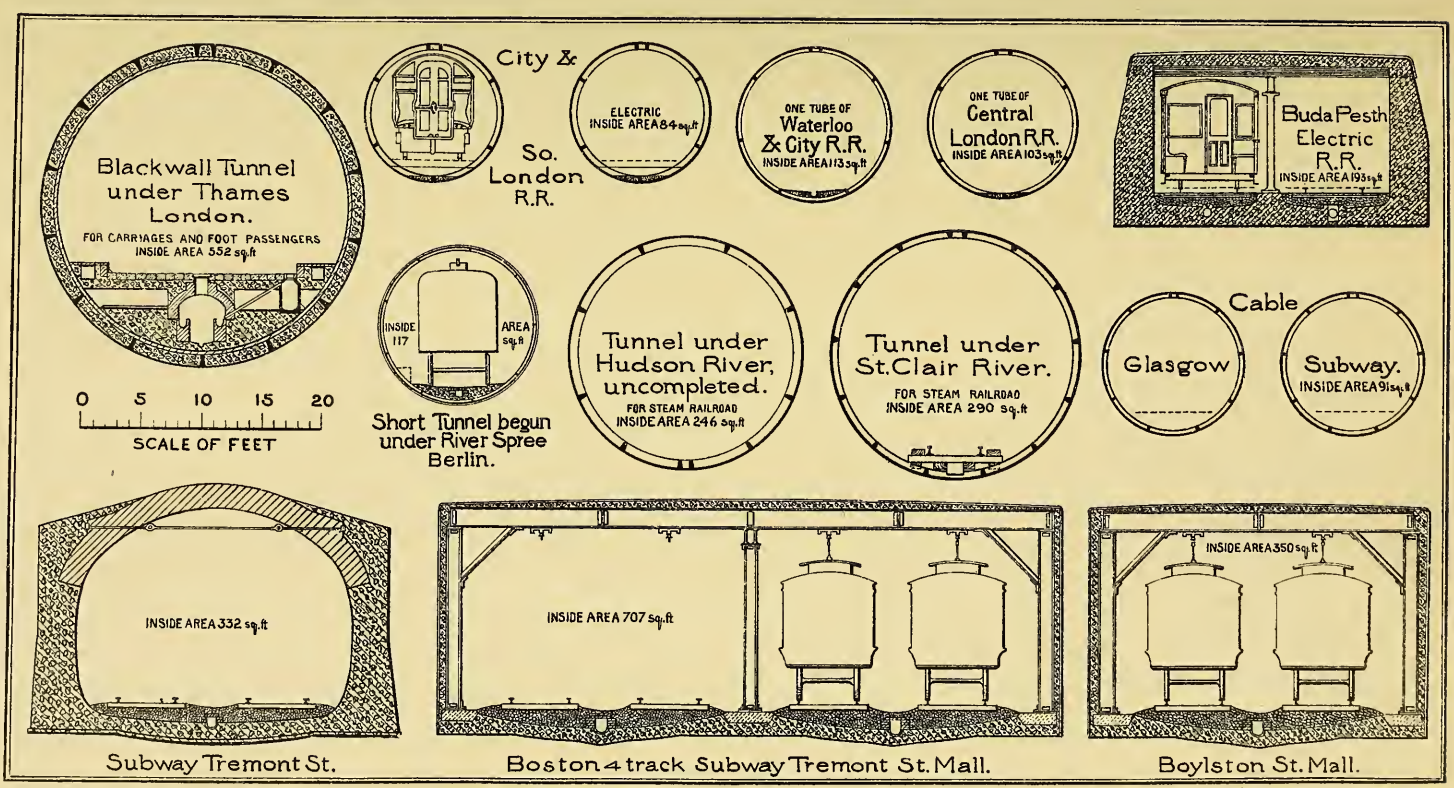
Section 6. ground. August 13, 1896, the Commission arranged with the Contractor that he was to cease work within one week, and the Chief Engineer was directed to proceed with the construction of the section by men directly employed by the Commission. The work done by the Contractor (which aggregated only about one-sixth of all the work done) consisted of a few, more or less, scattered slices and a few feet of tunnelling by the crown-bar method north of School street. The Commission in carrying on the work after the Contractor had ceased operations did some near Park-street church by the slice system and some by the same system north of School street, and tunnelled for a length of 550 feet by the method described in the fourth paragraph below.

Character of Excavation. — The excavation was mainly through sand, clay, and stones mixed in varying degrees of compactness. Only a very small volume of ground-water was encountered.

Method of doing Work. — As above stated, the slice system and tunnelling by the crown-bar method were employed on the portion of the work done by contract. On the work done directly by Commission the slice system and tunnelling with a roof shield. Surface traffic was maintained except during a portion of the night-time.

Force employed on Work done directly by the Commission after the Contractor had ceased. — Varied with the character of the operations, but the average was about 125 men and 8 double teams by day, and 85 men and 8 double teams by night.

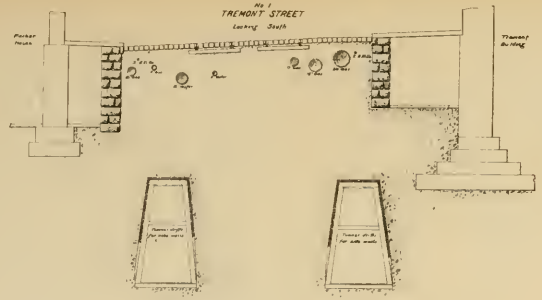
Use of a Roof Shield. — A portion of Section 6, south of School street, where the traffic was more dense than over any other portion of the subway, and where the subway was so deep as to interfere but little with the pipes, etc., was made by the use of a shield of peculiar construction and considerably wider than any hitherto used. In this case the side-walls were first built in small drifts, and the excavation for the arch, instead of being done from the surface, was effected under the roof of the shield. Its rear end formed the necessary support for the earth while the arch was being built under it. A track used for the shield to slide upon was imbedded in the top of the concrete side-wall and consisted (in each wall) of two 10-inch I-beams (connected by a bottom plate riveted to the flanges), on the upper flanges of which the cast steel shoes of the roof-shield rested. These shoes had rounded lower edges, and were connected with the shield by ball and socket joints. Cast-iron rods for the hydraulic rams of the shield to push against were built into the brick arch as the work progressed. Plates 15, 16, 17, and 18 illustrate this



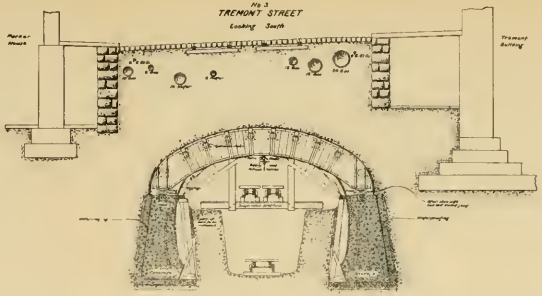
GEO. H. WALKER & CO. BOSTON.

PLATE 14. RELATIVE SIZES OF VARIOUS SUBWAYS.

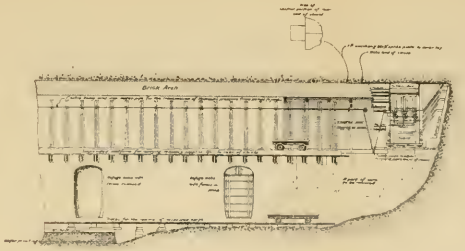
ALL WITH CIRCULAR CROSS-SECTIONS WERE EXCAVATED BY USE OF SHIELDS.



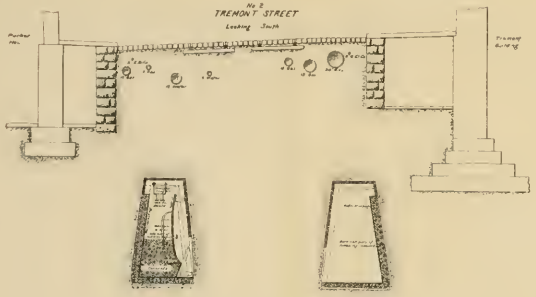
Cross section showing side drifts



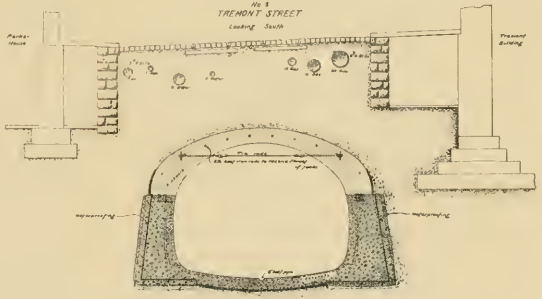
Cross section of head end of Shield



Longitudinal vertical section through Shield and Subway



Cross section indicating method of procedure in 2 stages



Cross section of completed Subway

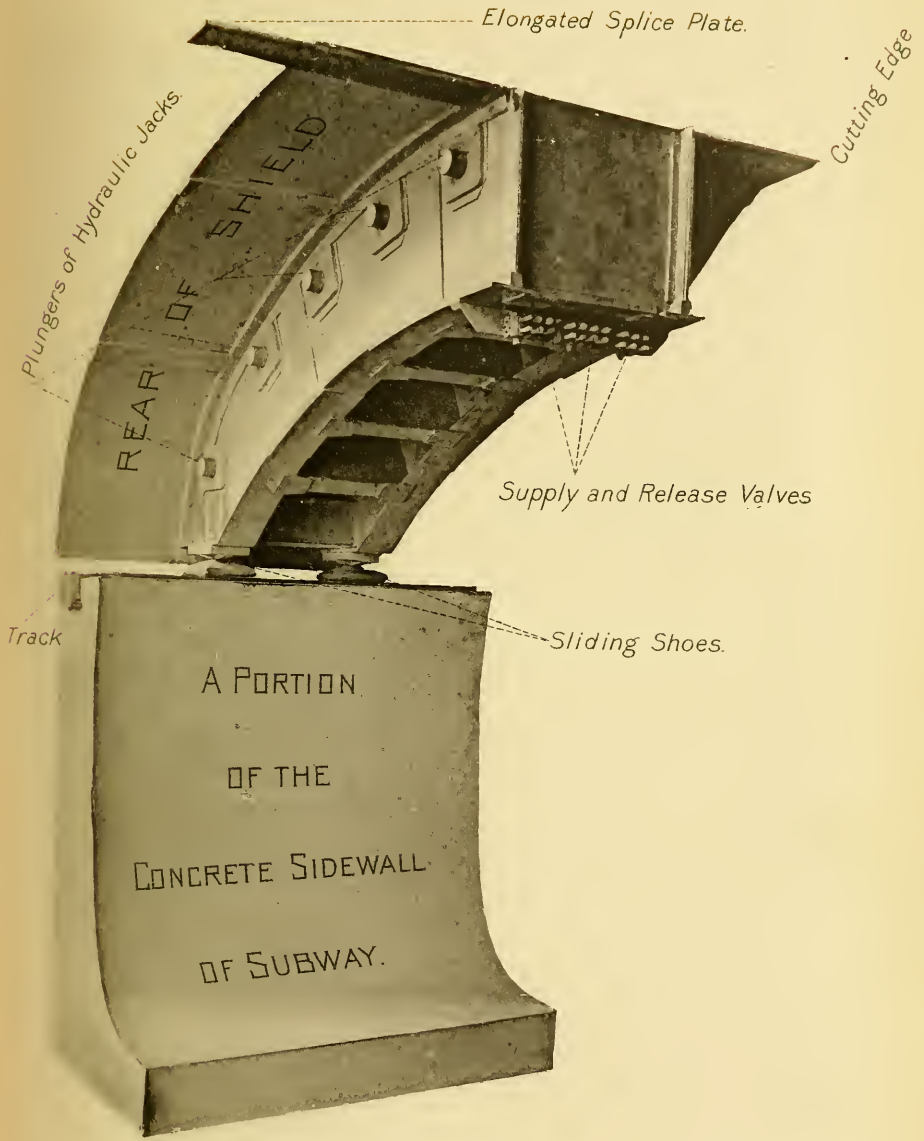
SECTION 6 TREMONT ST

TYPICAL CROSS SECTIONS OF THE SUBWAY SHOWING DIFFERENT STAGES IN THE PROGRESS OF THE WORK

Scale

H.A. Carson Chief Engineer

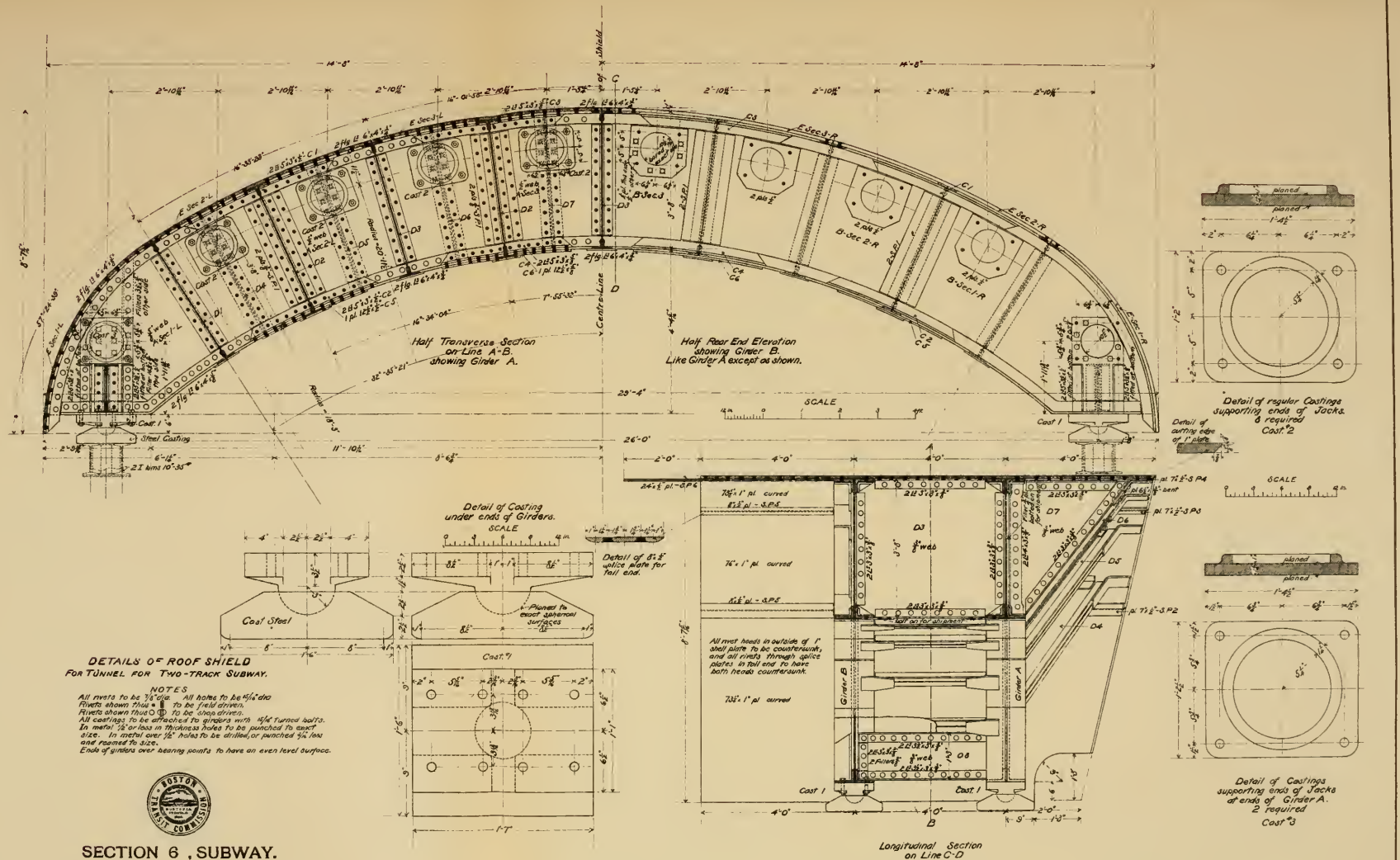
PLATE 15



STON TRANSIT COMMISSION

THE HELIOTYPE PRINTING CO., BOST

MODEL OF HALF OF ROOF-SHIELD AND PART OF SIDEWALL.
REAR END OF SHIELD.



DETAILS OF ROOF SHIELD
FOR TUNNEL FOR TWO-TRACK SUBWAY.

NOTES

All rivets to be ⅞"ø Ⓐ. All holes to be 15/16" dia
Rivets shown thus ● to be field driven.
Rivets shown thus ○ Ⓐ to be shop driven.
All castings to be attached to girders with 15/16" turned bolts.
In metal ⅞" or less in thickness holes to be punched to exact size. In metal over ⅞" holes to be drilled, or punched ¾" less and reamed to size.
Ends of girders over bearing points to have an even level surface.

BOSTON TRANSIT COMMISSION

SECTION 6, SUBWAY.

K. A. Carlson Chief Engineer

PLATE 17.

BED. N. WALKER & CO. LITH. BOSTON



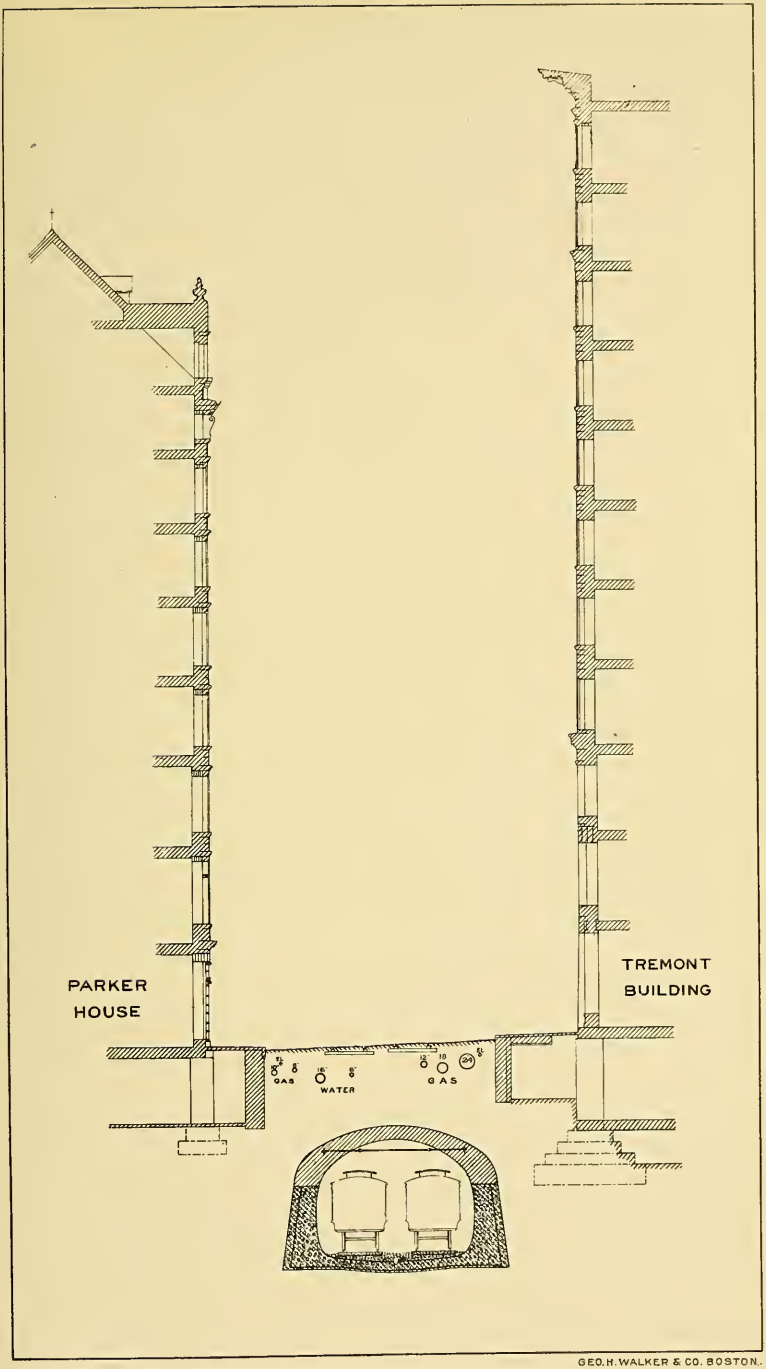


PLATE 18. CROSS SECTION TREMONT STREET, NEAR SCHOOL STREET (LOOKING SOUTH).

shield and the manner and place of using it. A roof-shield somewhat similar to the one described above was unsuccessfully tried on the Baltimore Belt Railroad in 1892, and a somewhat similar shield of smaller size was successfully used in constructing a sewer in Paris in 1896. The shield used in Paris had not been heard of by the writer at the time when the first design was made for the subway shield. In the final design the shield was somewhat longer and heavier and the two supporting transverse girders were more curved, but the type remained the same. Section 6.

Work done on **Section 7** (Scollay Square Station as originally planned) — Contract Work and Work done directly by the Commission.

(Description chiefly refers to Work done during the Year ending Aug. 15, 1898.)

Location. — In and near Scollay square, connecting with Section 6 in Tremont street, with Section 8 in Hanover street, and with Section 8½ in Cornhill.

Contractors for Steel Work. — The Carnegie Steel Company, Limited, Pittsburgh, Pa.

Contractors for Construction.—Shailer & Schniglau Company, of Chicago, Ill. Robert P. Lamont, Engineer and Secretary of the firm, acted as Superintendent.

City Assistants. — John E. Palmer continued as Assistant Engineer on the Ground, and the rest of the force also remained the same as given in Third Annual Report except that William Park was one of the Inspectors of Masonry for a portion of the season.

Buildings over Stairways. — These are illustrated by Plates 21 and 21*a*. For a statement concerning them see pages 48 and 64.

	Date of Contract.	Final certificate given (respectively of substantial completion of delivery of steel work or of substantial completion of construction).
Steel work . .	April 12, 1897.	Oct 10, 1897.
Construction . .	May 15, 1897.	Dec. 1, 1897.

Structure. — The structure is of the combined type. It is illustrated by Plates 19, 20, 22, 23, and 24.

A thin stratum of tar concrete and a thin stratum of sand is interposed between the roof of the station and the pavement, in order to reduce to a minimum the transmission of sound from the street to the station, and also in order to lessen vibration.

Work referred to in Third Annual Report. — A little over one-half of this section had been completed at the date of the Third Annual Report; namely, Aug. 15, 1897. The side walls were constructed directly by the Commission

Section 7. along those parts of the section where important buildings and other structures were in close proximity to the work. The bellmouth in Tremont street was built directly by the Commission.

Method of doing Work. — The side-walls were built in trenches, the upper portion of the earth between the trenches was removed, the roof was built, and the surface restored by bridging. Most of the work was done at night and in small parcels. The work was completed from underneath. The surface traffic was maintained except during a portion of the night-time.

Force employed, and Progress. — The force ordinarily employed by the contractors consisted of 55 men and 6 double teams working 11 hours in the day, and 70 men and 10 double teams working the same number of hours in the night. The following table shows the rate of progress from Aug. 15, 1897, to the completion of the work, also the total amount of work in the whole section :

Progress on Contract Work.

ITEMS.	Amount of work done previous to Aug. 15, 1897.	Date of completing.	Amount of work done during year ending Aug. 15, 1898.	Average rate of progress per week during respective working periods, year ending Aug. 15, 1898.	Total quantities in completed section.
	Cubic yards.	*1897.*	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
Excavation	10,288	Nov. 22	6,892	518	17,180
Concrete invert . .	309	Nov. 27	892	60	1,201
Granite footing-stones	27	Nov. 4	23	2	50
Steel erection . . .	279 tons	Nov. 23	237 tons	17 tons	516 tons
Concrete walls . . .	1,103	Nov. 6	87	7	1,190
Brick masonry . . .	86	Nov. 23	247	17	333
Concrete in roof . .	169	Nov. 24	651	45	820
Plastering	3,429 sq. yds.	Nov. 27	4,431 sq. yds.	295 sq. yds.	7,860 sq. yds.
Water-proofing . .	3,388 sq. yds.	Nov. 24	4,027 sq. yds.	279 sq. yds.	7,415 sq. yds.
Rib-tiling	842 sq. yds.	Nov. 25	19 sq. yds.	1.3 sq. yds.	861 sq. yds.

Operations were suspended for a short time on account of a brief delay in the delivery of steel, but nevertheless the section was completed within the specified time.

Character of Excavation. — The excavation consisted of fine dry sand, except at the junction of Tremont street and Pemberton square, where loose gravel was found. The average depth of excavation was about 23 feet. Very little ground-water was found.

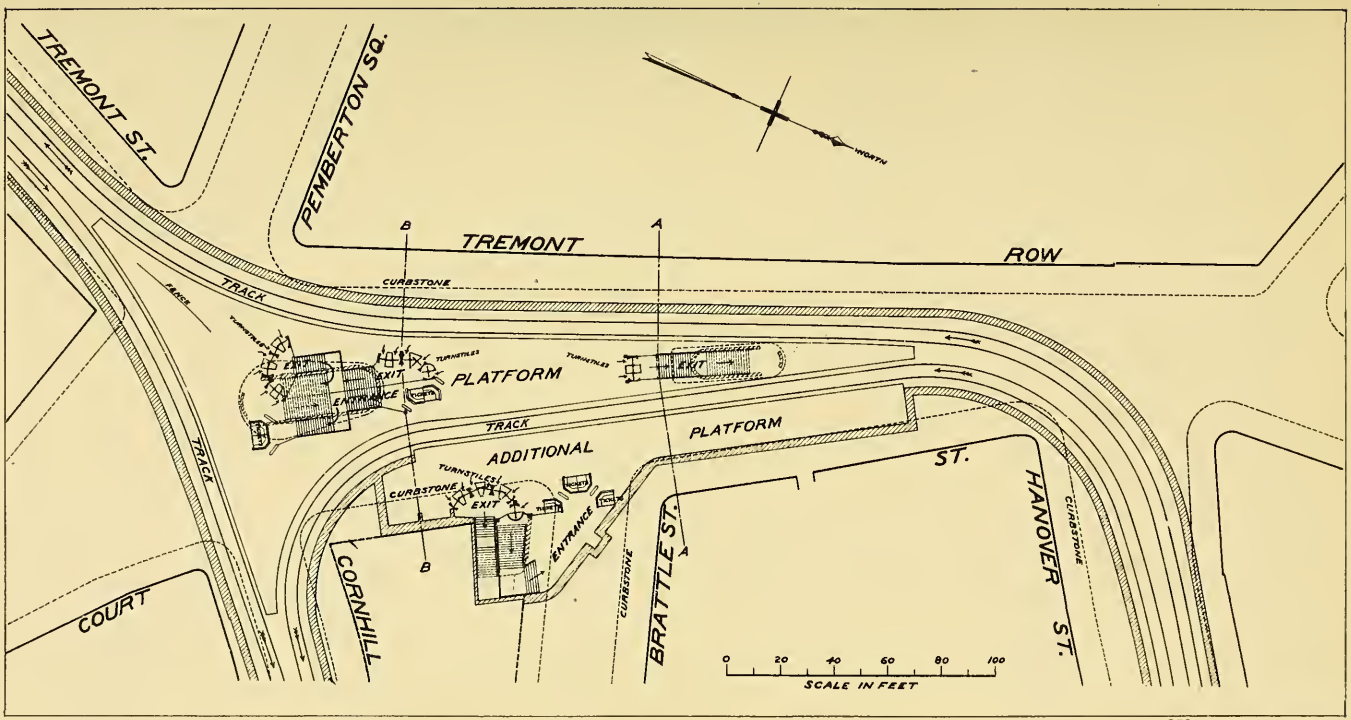


PLATE 19. PLAN OF SCOLLAY SQUARE STATION.

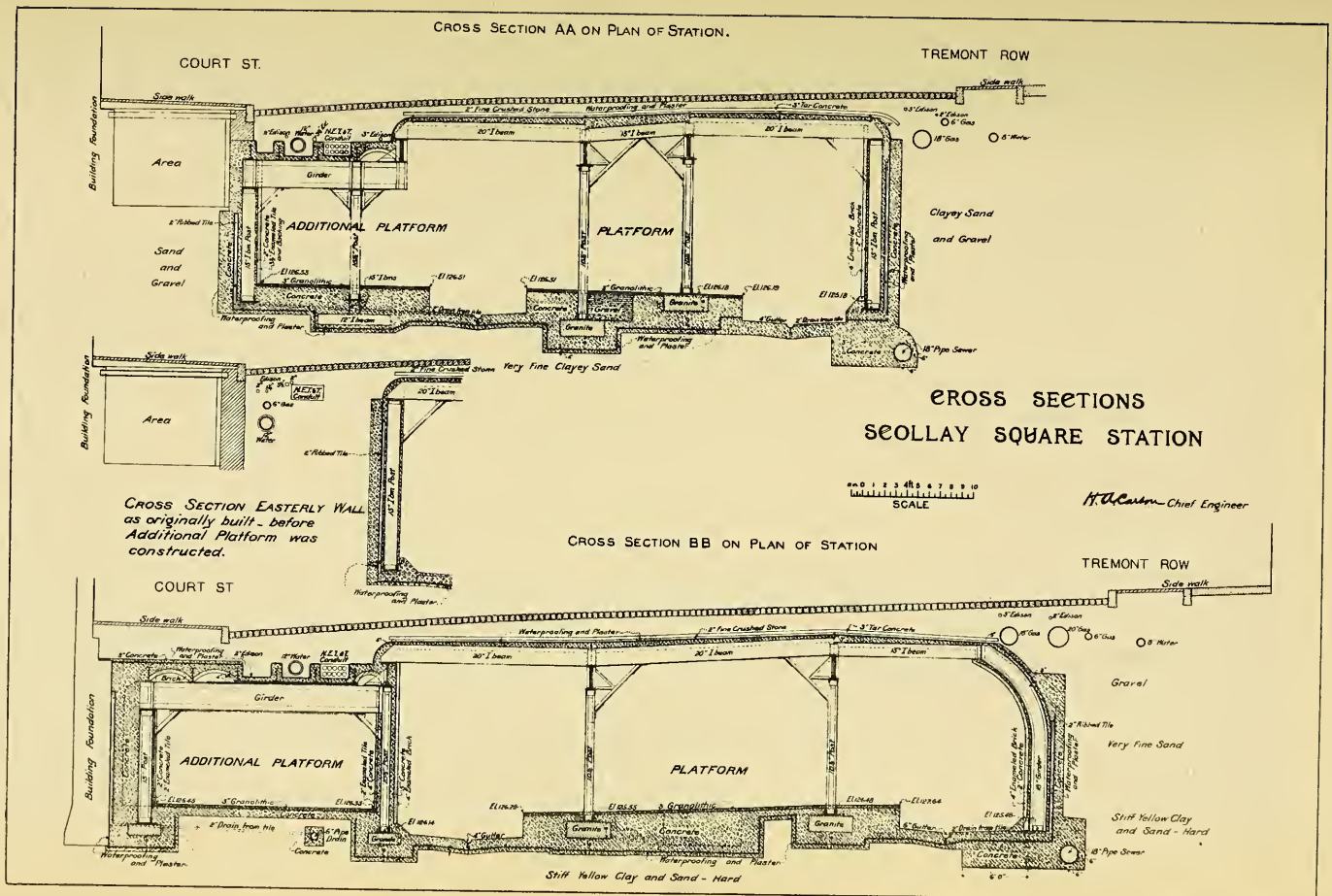


PLATE 20.

GEO. H. WALKER & CO. BOSTON



BOSTON TRANSIT COMMISSION

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 7.--BUILDING OVER STAIRWAY, CENTRE OF SCOLLAY SQUARE (LOOKING NORTHEASTERLY).

PLATE 21.



BOSTON TRANSIT COMMISSION

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 7.--BUILDING OVER EXIT STAIRWAY, NORTHERLY END OF SCOLLAY SQUARE (LOOKING SOUTHWESTERLY).

PLATE 21 A.



BOSTON TRANSIT COMMISSION

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 7.--SOUTHERLY END OF PLATFORM FOR NORTH-BOUND CARS, SCOLLAY-SQUARE STATION (LOOKING NORTH).

PLATE 22.

Addition to the Scollay Square Station (Contract Work).

(Constructed during the Year ending Aug. 15, 1898.)

City Assistants. — F. B. Edwards, Assistant Engineer on the Ground; Robert B. Farwell, Transitman; Carl S. Drake, Howard E. Smith,[1] Assistant Transitmen; Charles F. Cahill, Rodman; Charles R. Gow, Inspector.

An additional easterly platform, with a stairway to the surface at the southerly corner of Court and Brattle streets, has been joined to the Scollay-square station at the request of the Boston Elevated Railway Company. This has involved removing about 185 feet of the former easterly wall of the subway, tearing down the building on the southerly corner of Court and Brattle streets, underpinning buildings in that vicinity, and erecting a new two-story building for an entrance and exit.

The total cost of the change, exclusive of real estate, will be about $67,000. The assessed value of the real estate taken was $45,000.

Some of the details regarding the work are as follows:

Steel Work.

Contractor. — The Pennsylvania Steel Co., Steelton, Pa.
Date of contract, Feb. 8, 1898.
Final certificate given, Apr. 15, 1898.

Taking down and removing building numbered 77 Court street, southerly corner of Court and Brattle streets, putting in new foundations, underpinning, etc.

Contractor. — John S. Jacobs & Son, Boston, Mass.
Date of contract, Feb. 26, 1898.
Final certificate given, May 20, 1898.

The progress of this portion of the work has been as follows:

Items.	Date of beginning.	Date of completing.
Underpinning the front of the building numbered 69, 73, and 75 Court street	March 3, 1898	March 22, 1898
Taking down the building numbered 77 Court street and removing material	March 1, 1898	March 8, 1898
Excavation on the site of the torn down building at 77 Court street	March 21, 1898	April 4, 1898
Foundations for the building to take the place of the one torn down at 77 Court street	April 6, 1898	May 18, 1898
Erecting steel framework for new building	May 5, 1898	May 18, 1898

[1] Part of the time only.

Enlarging the Scollay-square station by building an addition (of the combined type) on the easterly side and removing as much of the existing subway as was necessary, including building a platform 198 feet long and from 20 to 64½ feet wide.

(*Illustrated by Plates 20 and 23.*)

Contractor. — GEORGE W. JUDD, Boston, Mass.
Date of contract, April 7, 1898.
Final certificate given June 1, 1898.

The progress was as follows:

ITEMS.	Date of beginning.	Date of completing.	Total quantities in completed work.
Earth excavation	April 9	May 19	3,083 cu. yds.
Surplus earth removed	April 9	June 1	2,500 cu. yds.
Old steel removed	April 9	April 27	9 tons.
Old masonry removed	April 11	April 28	243 cu. yds.
6-in. vitrified sewer-pipe connecting the southerly end of the station with the sewer in Brattle st., and draining Sects. 6 and 7	April 15	May 24	117 lin. ft.
Setting and securing iron and steel work	April 23	May 27	175 tons.
Brick masonry, Portland cement mortar	May 4	May 30	59 cu. yds.
Concrete masonry, Rosendale cement mortar	May 19	May 20	47 cu. yds.
Concrete masonry, Portland cement mortar	April 14	May 31	878 cu. yds.
Tiling for outside of walls	April 22	May 27	319 sq. yds.
Portland cement plastering	April 16	May 31	2,679 sq. yds.
2-in. tile drain on roof	May 7	May 31	228 lin. ft.
Water-proofing	April 17	May 31	2,154 sq. yds.

Two-story masonry building over the subway stairway at the junction of Brattle and Court streets, including adjacent sidewalk.

Contractor. — NORCROSS BROTHERS, Boston, Mass.
Date of contract, May 21, 1898.
Work begun, May 26, 1898.
Work substantially completed, Aug. 15, 1898.

Details regarding the Structure. — The building is 20 feet high on the Court-street side, and extends about 32 feet on Brattle street, and for about 23 feet on Court street. A glass awning projects over both the Brattle-street and the Court-street sidewalks, at a height of about 8 feet. There is some probability that within a few years, or even a few months, a large building will be constructed on Court street between Cornhill and Brattle street. The structure erected by the Commission has, therefore, above the sidewalk level been of a simple character, and has been so arranged that it can be incorporated in almost any style of building that may be

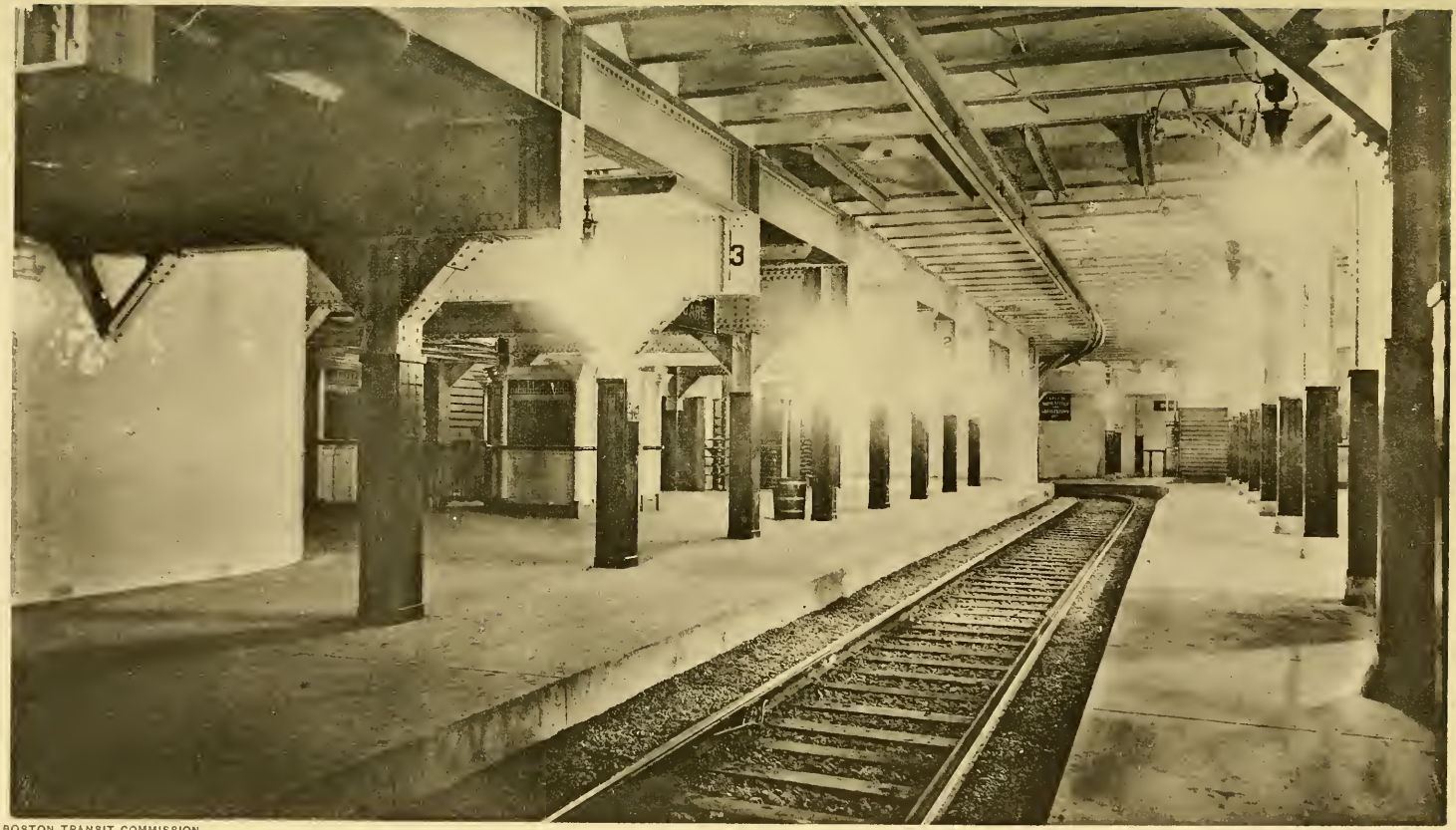


BOSTON TRANSIT COMMISSION

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 7.--PLATFORMS FOR RETURN LOOP, SCOLLAY-SQUARE STATION--NEW ADDITIONAL PLATFORM ON THE RIGHT (LOOKING NORTH).

PLATE 23.



BOSTON TRANSIT COMMISSION

THE HELIOTYPE PRINTING CO., BOSTON

PLATE 24.

SECTION 7.--PLATFORMS FOR RETURN LOOP, SCOLLAY-SQUARE STATION--NEW ADDITIONAL PLATFORM ON THE LEFT (LOOKING SOUTH).

erected, and conform therewith in appearance. The foundations and the steel skeleton in the first story of this building erected by the Commission have been made strong enough to support 9 additional stories of an office building, if it shall be desirable in the future to so extend the construction after having removed the present second story. Addition to the Scollay-square station.

Work done on **Section 8** of the Subway (Contract Work).

Contractors for Steel Work. — A. & P. Roberts Company, Philadelphia, Pa.
Contractors for Construction. — Metropolitan Construction Company, Boston.
Assistant Engineers on the Ground (City Assistants). — John E. Palmer (to Dec. 1, 1896), Frank C. Shepherd (from Dec. 1, 1896).

	Date of Contract.	Final certificate given (respectively of substantial completion of delivery of steel work or of substantial completion of construction).
Steel work . .	Sept. 17, 1896.	Nov. 21, 1896.
Construction . .	Oct. 8, 1896.	Mar. 19, 1897.

General Description of Structures. — The structure is a 2-track subway of steel and masonry combined type. Some of the posts and a portion of the sidewalls are curved at the top for the purpose of leaving a necessary space on the outside of the subway for water, gas, and other pipes. A cross-section of this subway showing air in-takes is given on Plate 31.

Character of Excavation. — The ground consisted of filling for the first 5 or 6 feet. The remainder was mainly blue clay, but between Elm street and the easterly end of the section some dry yellow sand was found. Little ground-water was encountered.

Method of doing Work. — This work was largely done at night. The operations resembled those on Section 7.

Force ordinarily employed by Contractor. — About 120 men and 7 double teams equally divided between 2 shifts (day and night) of 11 hours each.

Work done on **Section 8½** of the Subway (Contract Work).

Contractors for Steel Work. — A. & P. Roberts Co., Philadelphia, Pa.
Contractors for Construction. — National Contracting Company, New York City.
Assistant Engineer on the Ground (City Assistant). — F. B. Edwards.

	Date of Contract.	Final certificate given (respectively of substantial completion of delivery of steel work or of substantial completion of construction).
Steel work . .	Mar. 4, 1897.	June 8, 1897.
Construction . .	Mar. 31, 1897.	Sept. 3, 1897.

Section 8½. *General Description of Structures.* — The structure is a 2-track subway similar to Section 8. A cross-section of this subway, with a ventilating chamber, is given on Plate 30.

Character of Excavation. — First six feet in depth consisted of filling. Below was blue clay interspersed with thin layers of gravel at the Washington-street end of the section, and fine sand at the Court-street end. But little ground-water was encountered.

Method of doing Work. — Operations resembled those on Section 7. Surface was maintained, except during a portion of the night-time.

Force ordinarily employed by Contractor. — About 90 men, approximately, equally divided into 2 shifts (day and night) of 10 hours each. An average of 6 double teams employed during day, and 7 at night.

WORK DONE ON **Section 9** OF THE SUBWAY (CONTRACT WORK, AND WORK DONE DIRECTLY BY THE COMMISSION).

(Description chiefly refers to work done during the year ending Aug. 15, 1898.)

Location. — In Hanover street, between Portland and Washington streets, thence along Washington street to and through Adams square to Cornhill and Dock square.

Contractors for Curved Steel Side-posts. — HARRINGTON, ROBINSON, & CO., Boston.

Contractors for other Steel Work. — A. & P. ROBERTS CO., Philadelphia, Pa.

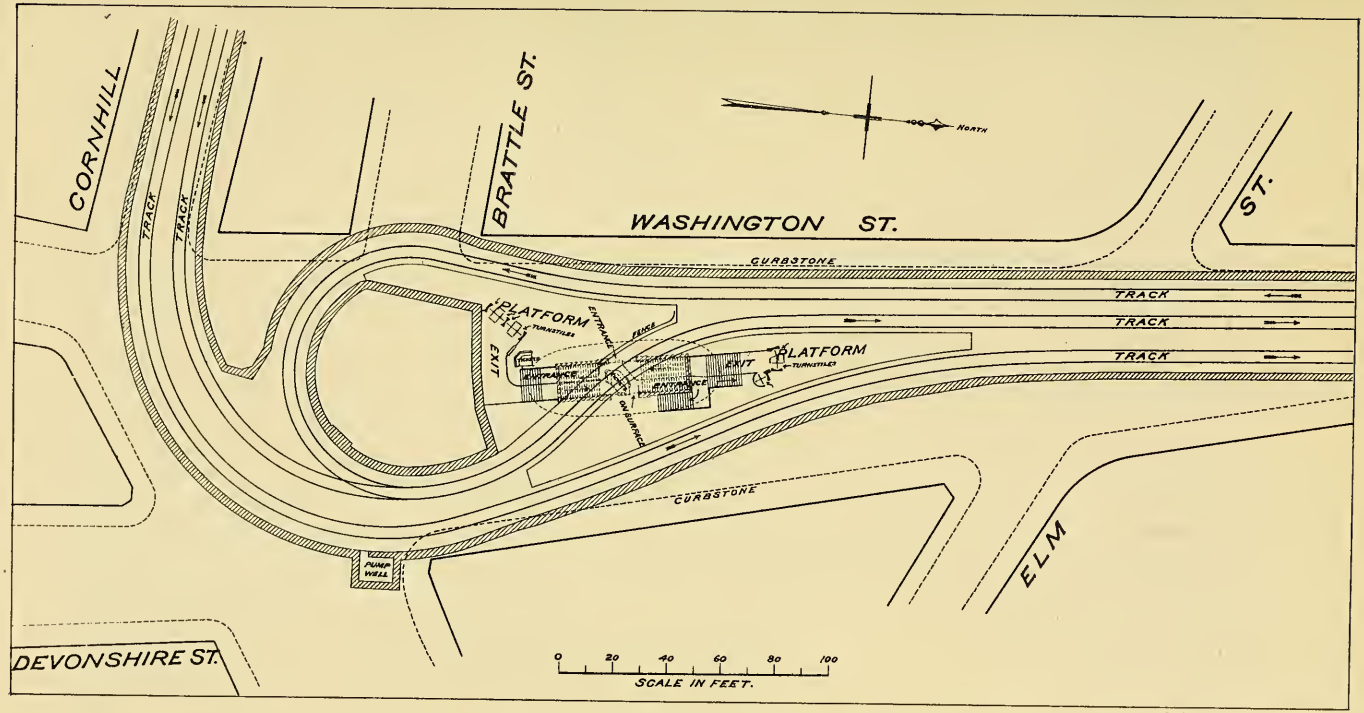
Contractors for Construction. — RICHARDSON & YOUNG, Chicago, Ill., ROBERT B. MUIR, Superintendent.

City Assistants. — John E. Palmer, Assistant Engineer on the ground (direct work); Frank C. Shepherd, Assistant Engineer on the ground (contract work), and the remainder of the force was also substantially the same as given in Third Annual Report.

Building over Stairways. — This is illustrated by Plate 26. For a statement concerning it see page 64.

	Date of Contract.	Final certificate given (respectively of substantial completion of delivery of steel work or of substantial completion of construction).
Curved side-posts	Oct. 15, 1896.	Dec. 15, 1896.
Other steel work	Jan. 15, 1897.	Aug. 30, 1897.
Construction	Mar. 6, 1897.	Dec. 1, 1897.

Work referred to in Third Annual Report. — At the date of the Third Annual Report (Aug. 15, 1897) the section was practically completed from the northerly end as far south as Elm street. Beyond this all the side-walls were completed, and south of Brattle street all the roof beams were in place, and part of the roof (where there are no centre columns) finished.



GEO. H. WALKER & CO. BOSTON.

PLATE 25. PLAN OF ADAMS SQUARE STATION.



N. L. STEBBINS, PHOTOGR.

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 9.--STAIRWAY BUILDING, ADAMS-SQUARE STATION (LOOKING NORTHEAST).

PLATE 26.



BOSTON TRANSIT COMMISSION

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 9.--NORTH-BOUND PLATFORM, ADAMS-SQUARE STATION (LOOKING SOUTH).

PLATE 27.

Section 9.

The greater part of the side-walls were put in directly by the Commission, and it also constructed a double channel sewer by means of a tunnel under Washington street and under the line of the subway at Hanover street.

General description of Structures and methods of doing work. — The section consists mainly of a 3-track subway, with a station and loop at Adams square. Its position and extent with relation to other portions of the work can be seen from the general map. Plates 25, 26, 27, and 30 are illustrative of this section. Where the 2-track portion from Hanover street converges into Section 10 on Washington street there is a short length of 4-track subway, with three rows of centre columns. The station is 220 feet long, with a maximum width of 104 feet. The station and subway are of the steel and masonry combined type. A 2-inch layer of sand was spread over the completed roof of the station, and above that was placed a 3-inch layer of tar concrete under the street pavement. This was to minimize the transmission of sound from the street to the station and also to lessen vibration.

The description of the methods adopted on Section 7 applies to a considerable portion of the work on Section 9.

Force employed. — The contract force consisted of about 140 men equally divided into day and night shifts of 10 and 11 hours respectively. When the work was nearing completion, however, the night shift was dispensed with. An average of 4 double teams per day and 4 by night was employed. The rate of progress is shown in the following table:

Section 9 Contract.

Items.	Amount of work done previous to Aug. 15, 1897.	Date of completing.	Amount of work done during year ending Aug. 15, 1898.	Average rate of progress per week during respective working periods, year ending Aug. 15, 1898.	Total quantities in completed section.
	Cubic yards.	*1897.*	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
Excavation	14,860	Nov. 11	9,209	728	24,069
Concrete invert	664	Nov. 26	1,345	91	2,009
Granite footing-stones	7	Oct. 22	24.8	2.5	31.8
Steel erection	493 tons	Nov. 2	198 tons	17.5 tons	691 tons
Concrete walls	939	Oct. 26	105	10	1,044
Brick masonry	267	Nov. 5	247	21	514
Concrete in roof	533	Nov. 7	638	53	1,171
Plastering	3,247 sq. yds.	Nov. 17	5,010 sq. yds.	373 sq. yds.	8,257 sq. yds.
Water-proofing	5,091	Nov. 18	5,104	376	10,195
Ribbed tiling	1,011	Nov. 17	34	3	1,045

Character of Excavation. — From 5 to 7 feet of filling was found over the entire section. Below this was hard blue clay, with fine loose sand in places, except at the foot of Brattle street and at the foot of Cornhill, where coarse gravel, containing more ground-water than elsewhere, was found. The ground-water was conducted by a 6-inch underdrain to a permanent pump well, and was there pumped by a 3-inch pulsometer. The sand under the old paving was of a very inferior quality from the north end of the section as far south as Brattle street, and consequently sand backfilling was furnished by the Commission.

WORK DONE ON **Section 10** OF THE SUBWAY (CONTRACT WORK, AND WORK DONE DIRECTLY BY THE COMMISSION).

Contractors for curved steel side-posts. — THE PENNSYLVANIA STEEL COMPANY, Steelton, Pa.

Contractors for steel work for station and for subway roof. — THE CARNEGIE STEEL COMPANY, Limited, Pittsburgh, Pa.

Contractors for construction. — SHAILER & SCHNIGLAU COMPANY, Chicago, Ill.

Assistant Engineer on the Ground (City Assistant). — JOHN E. PALMER.

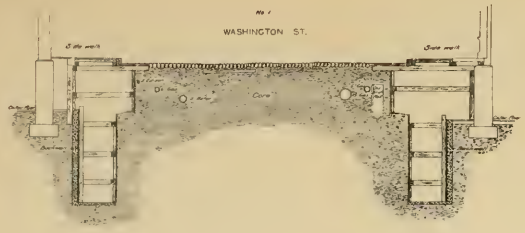
Building over Stairways. — This is illustrated by Plate 33. For a statement concerning it see pages 53 and 64.

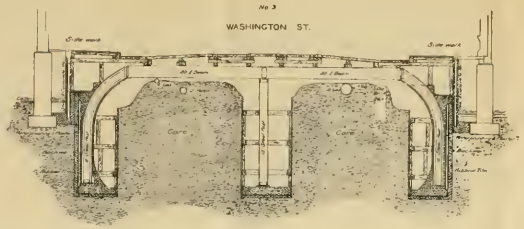
	Date of Contract.	Final certificate given (respectively of substantial completion of delivery of steel work or of substantial completion of construction).
Curved steel side-posts	July 28, 1896.	Oct. 10, 1886.
Steel in station and in subway roof .	Aug. 11, 1896.	Nov. 6, 1896.
Construction	Sept. 11, 1896.	Apr. 21, 1897.

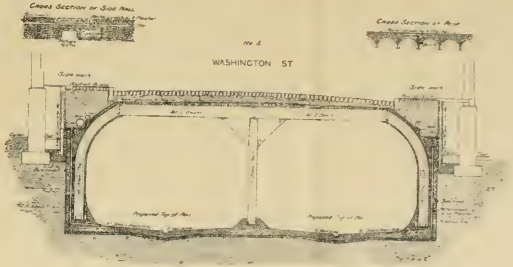
General description of Structures. — The four-track subway is of the steel and masonry combined type. Haymarket-square station is of construction similar to stations already described. Plates 28, 32, and 34 are illustrative of the structure.

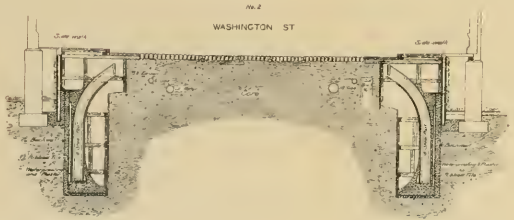
Character of Excavation.— The depth of excavation from surface to under side of subway invert varied little from 20 feet throughout the section. At the northerly end of the station, owing to presence of peat from a level of 12 feet below the street surface, it was necessary to take out 2 or 3 feet additional. Stiff yellow clay was found throughout most of the Washington street part of the section except at the northwesterly corner of Hanover and Washington streets, where sand and gravel were met with. Peat and filled material was found in Haymarket square.

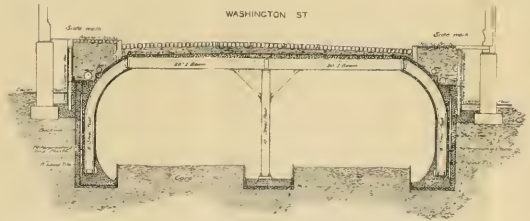
Method of doing Work. — The method was substantially as is described in the fifth paragraph on page 62 and illustrated on Plate 28.











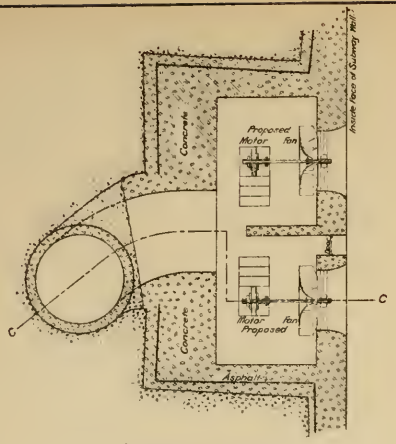
SECTION 10 WASHINGTON ST

TYPICAL CROSS SECTIONS OF THE SUBWAY SHOWING DIFFERENT STAGES IN THE PROGRESS OF THE WORK

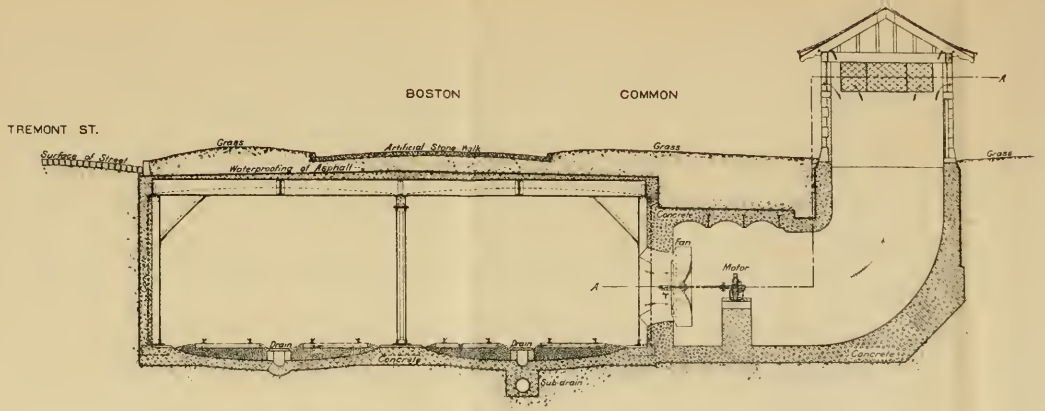
Scale

W. J. Wilgus Chief Engineer

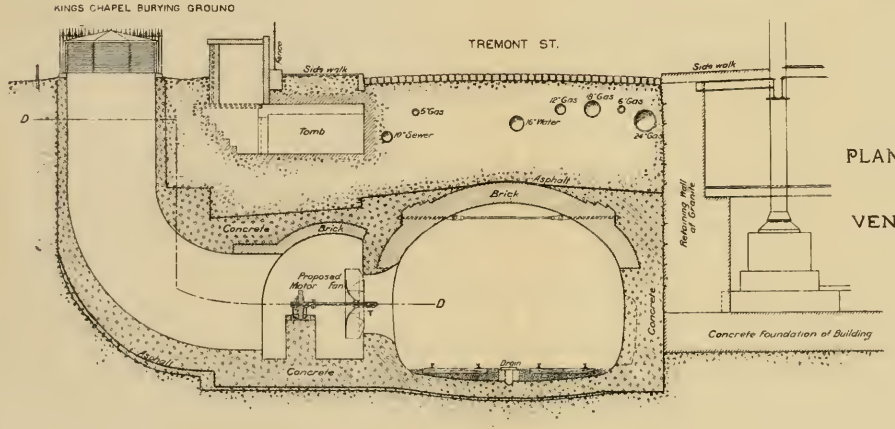
PLATE 28



PLAN OF VENTILATING CHAMBER
SECTION ON LINE OO.



FOUR TRACK SUBWAY AND VENTILATING CHAMBER
NEAR WEST ST.
SECTION ON LINE BB.

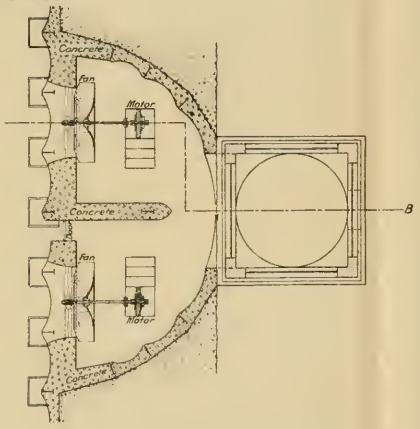


TWO TRACK SUBWAY AND VENTILATING CHAMBER
NORTH OF SCHOOL ST.
SECTION ON LINE CC

PLANS AND SECTIONS
OF TWO
VENTILATING CHAMBERS

SCALE

H. A. Carson Chief Engineer.

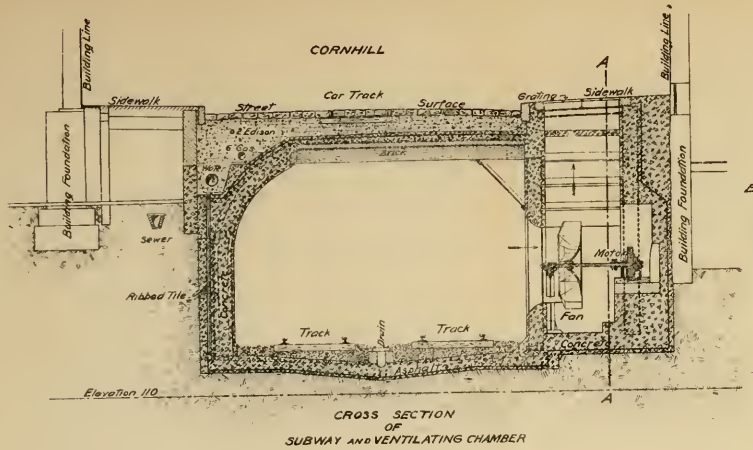


PLAN OF VENTILATING CHAMBER
SECTION ON LINE AA.

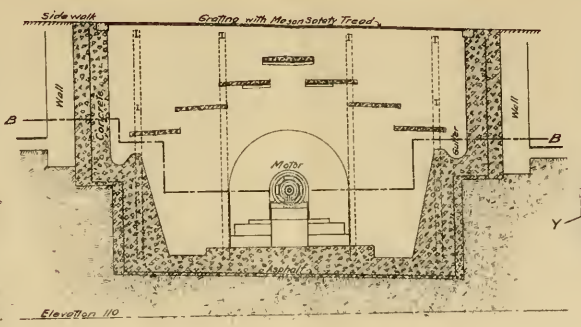
PLATE 29

GEO. H. ... HER & CO. BOSTON

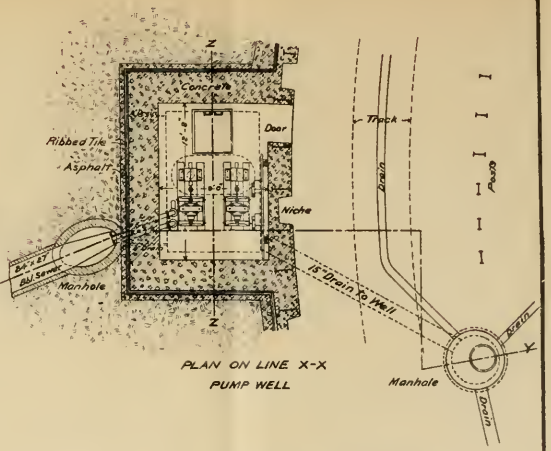




CROSS SECTION
OF
SUBWAY AND VENTILATING CHAMBER

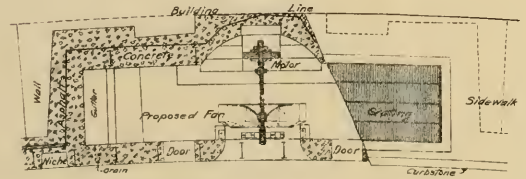


SECTION ON LINE A-A



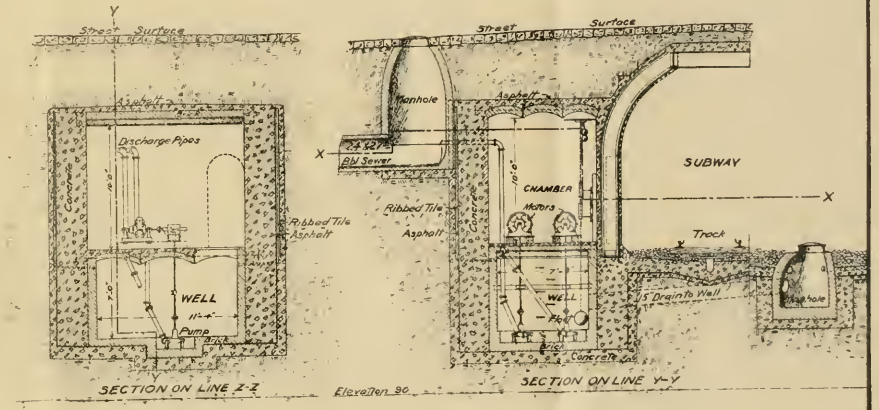
PLAN ON LINE X-X
PUMP WELL

VENTILATING CHAMBER SECTION 8½
CORNHILL



PART SECTION
ON LINE B-B

PART PLAN



SECTION ON LINE Z-Z

SECTION ON LINE Y-Y

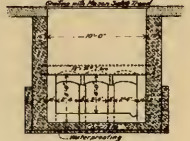
12in. 0 2 4 6 8 10 12ft.
SCALE

PUMP WELL SECTION 9 ADAMS SQUARE

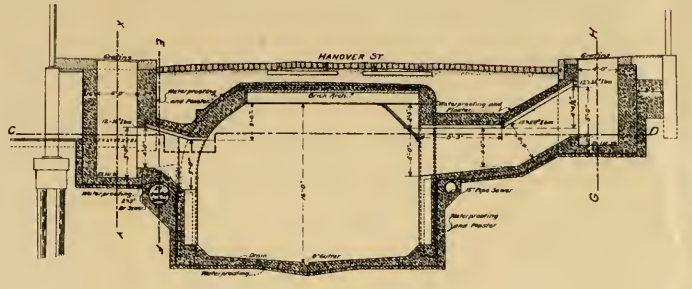
Chief Engineer

PLATE 30

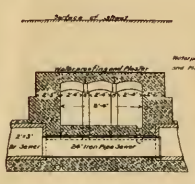
DEGN WALKER & CO BOSTON



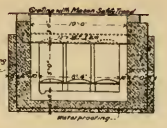
SECTION ON X-Y



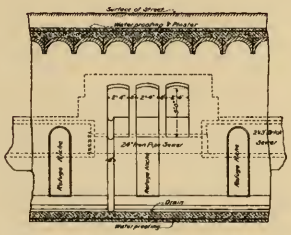
SECTION ON A-B



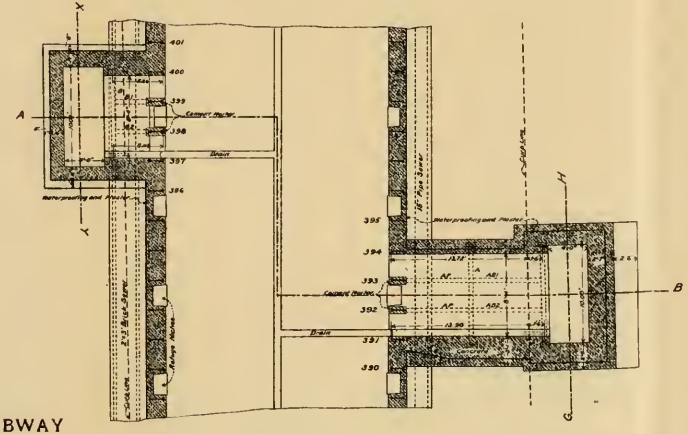
SECTION ON E-F



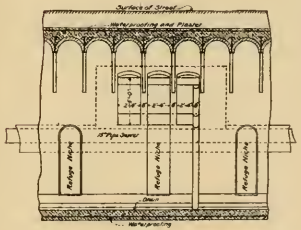
SECTION ON G-H



INTERIOR ELEVATION, SOUTH SIDE



PLAN ON C-D



INTERIOR ELEVATION - NORTH SIDE

DETAILS OF AIR INTAKES

RECORD PLAN. BOSTON TRANSIT COMMISSION SECTION 8, SUBWAY

H. A. Carlson
Chief Engineer

PLATE 31

GEO. H. WALKER & CO. LITH. BOSTON



Some of the Work done directly by the Commission or done by minor contract. — The side-walls for the 4-track subway were built by direct work. These side-walls came very close to the front of the buildings and extended about 10 feet below their foundations. A 24-inch water main was laid as an inverted siphon diagonally across beneath the subway opposite Union street in Haymarket square south of the station. A wood sewer 4 feet square which crossed the line of the subway at the station in Haymarket square was replaced by means of a temporary inverted siphon about 108 feet long, 5 feet high, 4 feet wide at the bottom and 2½ feet wide at the top. It consisted of a wooden framework and lining and a concrete and grout filling between the woodwork of the siphon and the tunnel lagging. This siphon was built in a tunnel previous to the construction of the subway station. Section 10.

Force ordinarily employed. — Two 11-hour shifts composed of about 80 men during the day and 50 at night, with 10 double teams all the time by contractor on construction; 150 men and 15 double teams working two 11-hour shifts per day in the general proportion of 60 day men to 90 night men on work done directly by the Commission.

Building over Stairways at Haymarket Square.

(Constructed wholly during the year ending Aug. 15, 1898.)

Contractors.

Furnishing and erecting steel work, Edward Kendall & Sons, Cambridgeport, Mass.
Furnishing and putting in place wood work, copper work, and glass work, John Y. Mainland, Boston.
Furnishing marble, Vermont Marble Company, Boston.
Furnishing and putting in place wood finish around stairs, Estate of John A. Robertson, Boston.
Furnishing and putting in place doors, door-posts, sash and transoms, Isaac McLean, Boston.

Table of Progress.

	Date of Contract or order.	Date of beginning erection.	Final certificate given.
Steel work	Aug. 9, 1897.	Nov. 17, 1897.	Dec. 27, 1897.
Wood work, copper work, and glass work . . .	Dec. 2, 1897.	Dec. 22, 1897.	Mar. 21, 1898.
Wood finish around stairs, etc.	April 22, 1898.	About June 1, 1898.	June 13, 1898.
Doors, door-posts, etc.,	May 3, 1898.	May 20, 1898.	Substantially finished, June 16, 1898.

Building over stairways at Haymarket square.

Each of the two island platforms in Haymarket-square station has a stairway ascending from it and a single building covers both stairways. The building is about 34 feet long and 32 feet wide, its long axis running nearly north and south. The northeast and southwest quadrants of the building are curves, in each of which are four double doors. The irregular shape of the building was necessary on account of the position of the electric surface tracks near by. The building has a steel skeleton with vertical members supporting the truss-work of the roof. The latter is of matched and beaded oak inside and its outside is of sheet copper. The roof projects beyond the building walls about 5½ feet. The apex of the roof is a skylight and ventilator about 8 feet in diameter. The walls of the building are formed by thin panels attached to the vertical T members of the steel skeleton. The panels are of cast iron to a height of about 12 inches from the sidewalk. Above the cast iron are Listavena marble slabs 3 inches thick (constituting the entire thickness of the wall) tooled on the outside and polished within. These slabs have a height of 5 feet on the sides of the building and of 6½ feet on the ends. They are so secured that they can be readily taken out and replaced at any time. Above these marble slabs are large plate-glass windows, and above the latter is a metal grill work for the admission of air. The finish of doors, windows, and stairs is of white oak.

The cost of this station building, including stairways, was about $7,500. It is illustrated on Plates 32 and 33.

WORK DONE ON **Section 11** OF THE SUBWAY (CONTRACT WORK) CONSTRUCTED WHOLLY DURING THE YEAR ENDING AUG. 15, 1898.

Location. — Under and adjoining the site of the old Haymarket-square station of the Boston & Maine Railroad, or from the northerly end of Section 10 in Haymarket square to a point on the westerly side of Haverhill street about 125 feet south from Travers street.

Contractor for Steel Work. — NEW JERSEY STEEL & IRON COMPANY, Trenton, N.J.

Contractor for Construction.— CHARLES LINEHAN, Cambridge, Mass., A. E. WEAVING, Superintendent.

City Assistants. — F. B. Edwards, Assistant Engineer on the ground; E. St. J. Maunsell,[1] William O. Wellington,[1] Frank H. Morris,[1] transitmen; Thomas W. Bailey, Perley B. Palmer, assistant transitmen; Leonardo Furlong, rodman; A. W. Parker, inspector of steel work; Samuel Corning, inspector of masonry and pile driving; George H. Foss, Jr., inspector of masonry; William Park, inspector of pile driving.

[1] Part of the time only.

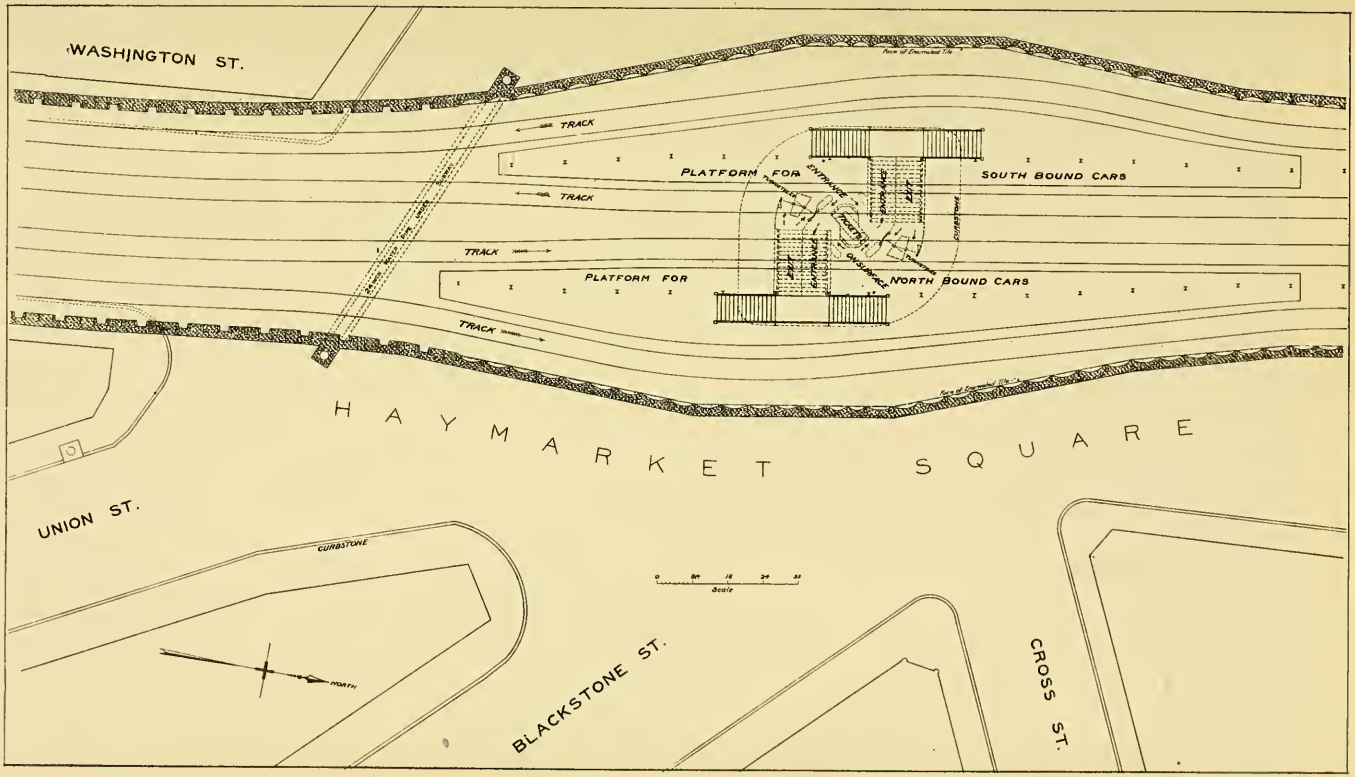


PLATE 32. PLAN OF HAYMARKET SQUARE STATION.



N. L. STEBBINS, PHOTOGR.

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 10.--STAIRWAY BUILDING, HAYMARKET-SQUARE STATION (LOOKING NORTH).

PLATE 33.



BOSTON TRANSIT COMMISSION

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 10.--HAYMARKET-SQUARE STATION, SOUTH-BOUND PLATFORM (LOOKING NORTH).

PLATE 34.

	Date of Contract.	Final certificate given (respectively of substantial completion of delivery of steel work or of substantial completion of contruction).	Section 11.
Steel work . .	Aug. 13, 1897,	Jan. 31, 1898.	
Construction . .	Oct. 30, 1897.	July 5, 1898.	

General Description of Structures. — The position and extent of the section in relation to the rest of the subway can be seen on the general map. Beginning at the northerly end of this section and extending southerly for about 286 linear feet is an open inclined 4-track approach to the subway, with side-walls of dimension granite backed by concrete and surmounted by granite coping. These side-walls have a sustaining power in addition to their own weight such as would enable a 6-story manufacturing building to be constructed over them, with the weights required by the present building laws. Refuge niches are made in each of the walls at intervals of 20 feet (except near the upper end where the walls lack sufficient height), each niche being about 7½ feet high, 4 feet wide, and 15 inches deep. The side-walls are from about 44½ to 51 feet apart; this space, as already stated, accommodating 4 tracks.

The remainder of Section 11 consists of a 4-track subway of steel and masonry combined type extending from the foot of incline about 168 feet to the northerly end of the Haymarket-square station.

This subway is 51 feet wide in the clear at the portal and about three feet wider near the station. The roof of this covered portion is composed of steel beams running crosswise of the subway, with concrete jack arches between and its side-walls consist of concrete with steel posts imbedded therein. The roof is partly supported by two rows of columns running lengthwise of the structure. Each row is from 12½ to 14 feet from the nearer side-wall, and its columns are about 6 feet apart on centres.

Near the southerly end of the section in Haymarket square provision is made for pipes crossing in the roof of the subway.

On the west side of the section and near Haymarket square is a pump-well with a pump chamber above, whose floor is at about the same elevation as the adjoining floor of the subway. This pump chamber contains 2 centrifugal pumps (one of them as a reserve) operated by electricity and working automatically by means of floats. Plates 35 and 36 are illustrative of Section 11.

Method of doing Work. — The work was done in open trench and most of it without bracing. The earth for about

Section 11. five feet below the surface was shovelled into carts by laborers. When greater depths were reached the excavated earth was lifted in skips by fixed derricks operated by steam-engines. The same derricks were used in laying the stone masonry, depositing concrete in place, and erecting the steel work. Fifty-five men were ordinarily employed, working ten hours each day. The work was all done in the day, with the exception of a few nights' work when the section was nearing completion. The rate of progress, etc., is shown in the following table:

Progress.

ITEMS.	Date of beginning.	Date of completing.	Total quantities in completed section.	Average rate of progress per week during respective working period.
		1898.	*cu. yds.*	*cu. yds.*
Excavation	Nov. 2, 1897	May 6	16,848	634
Piles	Nov. 24, 1897	March 28	77,620 lin. ft.	4,336 lin. ft.
Concrete invert	Dec. 20, 1897	July 5	3,680	131
Granite footing-stones	April 19, 1898	May 14	48	13
Steel erection	April 19, 1898	June 11	281 tons.	37 tons.
Concrete walls	Dec. 23, 1897	June 27	1,716	64
Brick masonry	March 10, 1898	April 14	12	3
Concrete in roof	June 6, 1898	July 1	610	165
Granite masonry	Jan. 18, 1898	May 23	437	24
Plastering	Dec. 26, 1897	June 30	3,964 sq. yds.	148 sq. yds.
Water-proofing	Dec. 24, 1897	July 1	7,035 " "	260 " "
American concrete masonry under invert	March 28, 1898	May 17	480 cu. yds.	66 cu. yds.
Rib tiling	April 25, 1898	June 17	608 sq. yds.	79 sq. yds.

Character of Excavation and Foundation. — In the early days of Boston the tide ebbed and flowed over the whole of the site of the section. At a later time a portion of the site was the bed of the old Middlesex canal. Still later, the refilling of the bay and canal was made partly with mud and silty material (probably dredged from near-by bays and channels) and was topped with about 6 feet of gravel. Many logs and piles and portions of the foundation of the old Boston & Maine station (most of which building had been torn down and removed a short time before under a contract with J. J. Reagan & Co.) were encountered. The concrete of the invert at the southerly end of the section is carried down to stiff blue clay. All of the incline approach and 54 feet of the adjoining length of the subway is supported upon piles driven through the silty filling mentioned above. There are 2,530 of these piles, averaging about 31 feet in length. Five hundred and twenty-four old piles under the walls of the old Boston & Maine station were given additional driving, and served in place of new piles. Constant pumping was

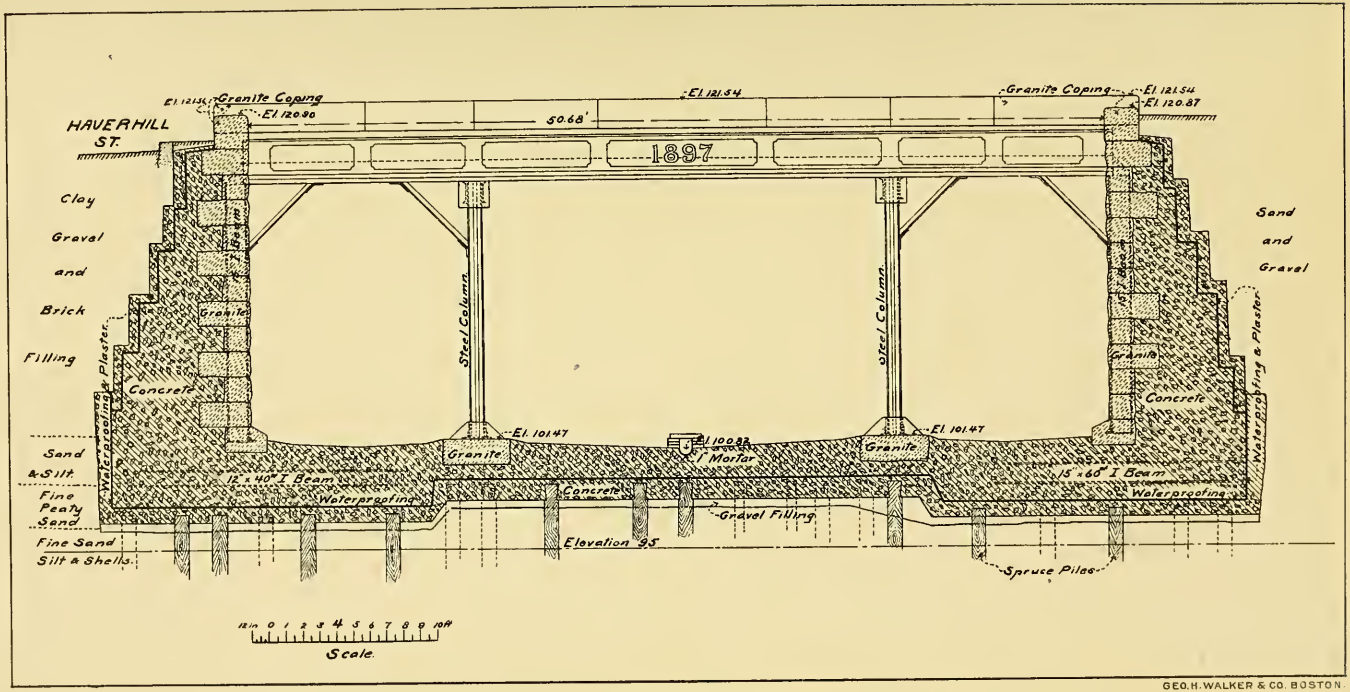


BOSTON TRANSIT COMMISSION

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 11.--STEEL-WORK NEAR PORTAL (LOOKING SOUTH). MAY 23, 1898.

PLATE 35.



GEO. H. WALKER & CO. BOSTON.

PLATE 36. CROSS SECTION AT NORTHERLY PORTAL NEAR HAYMARKET SQUARE.

required from about Dec. 1, 1897, to July 14, 1898. Section 11. Numerous drains laid below the invert conveyed the water to be pumped to the lowest place excavated, and from thence to a temporary well adjoining the pump chamber.

Clearing ground in block bounded by Causeway, Canal, Travers, and Haverhill streets. — The buildings and track on this ground were removed during the spring and summer of 1898. The contractors were J. J. Reagan & Co.

[End of Condensed Statement by Contract Sections.]

Surface and Subsurface Surveys, Plans, Data, Consultations, etc.

The engineering organization was made and preliminary work was begun in September, 1894. The names of those who have at any time worked in the Engineering Department, including inspectors, are given in the several annual reports. I desire to express to these assistants my gratitude for the zeal and efficiency with which their services were performed.

The first work of the Engineering Department was to collect and arrange information bearing on the subject of the subway, including that which had been gathered by preceding commissions.

Most of the subway route lies along narrow streets the ground near the surface of which is nearly filled with street railways, gas-pipes, water-pipes, electric conduits, sewers, etc. The subway construction extends deeper than the foundations of most of the buildings which lie along the side. Injury to these structures would necessarily have entailed a great loss. The subway was so planned and built as to almost entirely avoid such injury.

In order to make intelligent and economical designs it was necessary to get exact information as to the position of these pipes, sewers, buildings, etc. This needed information was obtained by surveys and by examinations and compilations some account of which is given in the first and other annual reports.

Original surface surveys were made of all the ground through which the subway was built, and of various neighboring streets and grounds through which alternative routes were considered. The plans made from these surveys show all building fronts, manholes, sidewalks, lamp and electric posts, trees, fences, street-car tracks, and other surface objects.

The sub-surface surveys included frequent borings extending from twenty to eighty feet below the surface; test

Surface and sub-surface surveys, plans, data, consultations, etc.

pits in some localities, to show more surely the character of the soil; excavations in cellars and basements to the bottom of the foundations of the adjacent buildings, to discover the character, thickness, and level of the walls; trenches, and in some cases tunnel drifts along and across the street, to more accurately locate pipes, sewers, etc.

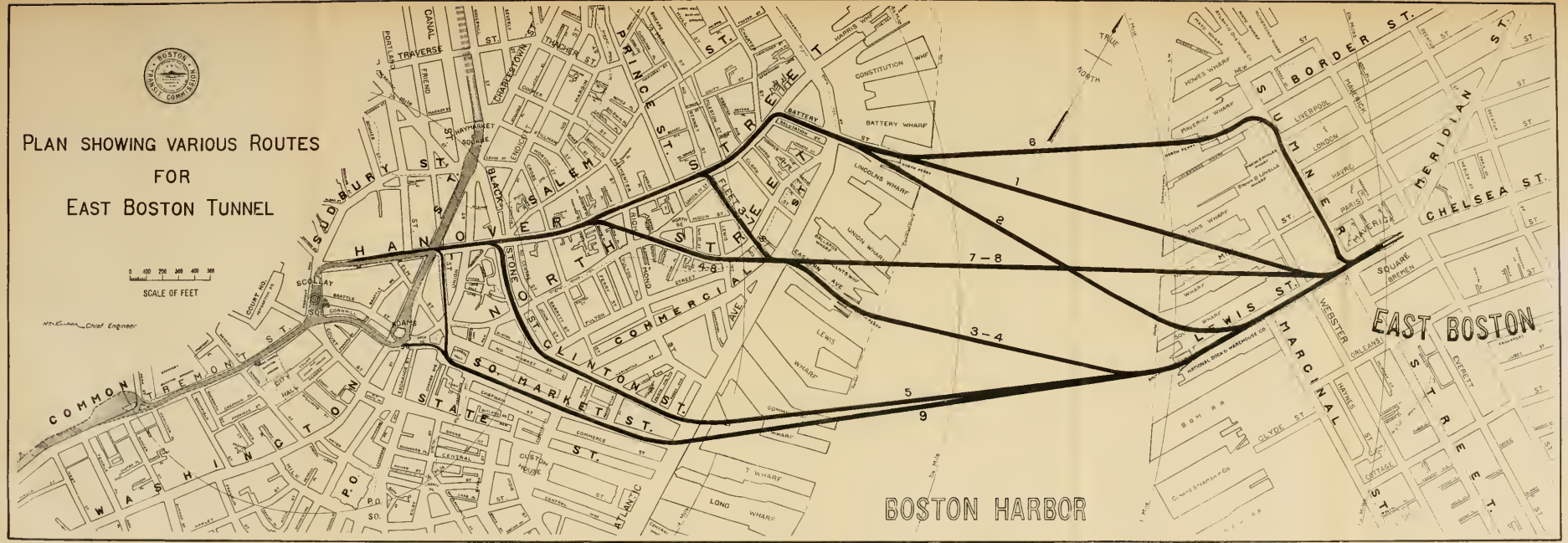
The plans which have been made and indexed for the subway work number in all about 4,000.

The Water, Fire, Wire, and Street Commissioners, the Superintendent of Streets, the City Engineer, Gas Company officials, and others were consulted in regard to details concerning their respective departments. Advice and suggestions were also received from many eminent and experienced engineers, the names of some of whom are given on page 35 of the First Annual Report.

STUDIES FOR STATIONS, TRACKS, PLATFORMS, STAIRWAYS, DISCUSSIONS WITH OFFICERS AND EXPERTS OF THE RAILWAY COMPANY, ALIGNMENT, GRADES.

It was constantly kept in mind that with the novel conditions of and limitations imposed upon the subway the prudent course was to thoroughly work out the plans before construction began, and therefore a great deal of time was spent in studies of the routes to be taken, and the best ways of arranging the stations and terminals for handling in the most convenient manner the largest amount of traffic. The Commissioners personally devoted a great deal of time to the study of these details, and many of the characteristic features of the subway — such, for example, as the sub-subway — originated, so far as this work is concerned, with them. In connection with the foregoing it may be stated that about seventy studies were made for the proposed Causeway-street station and connections therewith, and many studies were made for each of the other stations. The plans were, before adoption, examined by experts of long experience, for criticism and suggestion. A few of the studies for the Causeway-street station, and a few of the studies for subway routes between Scollay square and Haymarket square are given opposite pages 24 and 25 of the Second Annual Report.

As it appeared probable from the first that the subway would be leased by the West End Street Railway Company, the plans were discussed with the executive officers of that company as the work progressed. Among other things considered were the position and arrangement of stations, grades, width and shape of platforms, width of stairways, general plan of construction, general dimensions, sub-subways,


PLAN SHOWING VARIOUS ROUTES
FOR
EAST BOSTON TUNNEL
BOSTON TRANSIT COMMISSION
SCALE OF FEET
H. M. Rice, Chief Engineer
TRUE NORTH
6
1
2
7-8
3-4
5
9
4-8
BOSTON HARBOR
EAST BOSTON
COMMON
WASHINGTON
TREMONT ST.
SCOLLAY SQ.
HANOVER ST.
SALEM ST.
BLACKSTONE ST.
NORTH ST.
PRINCE ST.
STILLMAN ST.
FLEET ST.
BATTERY ST.
COMMERCIAL ST.
ATLANTIC AVE.
STATE ST.
SO. MARKET ST.
CUSTOM HOUSE
LONG WHARF
T WHARF
CONSTITUTION WHF.
BATTERY WHARF
LINCOLNS WHARF
UNION WHARF
LEWIS WHARF
CUNARD STEAMSHIP CO
NATIONAL DOCK & WAREHOUSE CO
BOSTON & ME. R.R.
MARGINAL ST.
BORDER ST.
MERIDIAN ST.
CHELSEA ST.
WEBSTER ST.
EVERETT ST.
SQUARE
PLATE 37.

cross-overs and curves. Discussions began some months before the first excavation in the Public Garden. Such changes were made as were finally recommended by the officers of the company prior to the letting of the contracts, and the plans as adopted were approved by them. It was decided that the two easterly tracks of the 4-track subway should be for north-bound cars, and should have island platforms between them at stations; that the two westerly tracks should be for south-bound cars, and should also have island platforms between them; that the platforms should be as wide and as long as the legal and other practically unchangeable limitations permitted; that the stairways on the Common should be fifteen feet wide; that the distance between the top of the track rails and the roof of the subway should be fourteen feet; and that the platforms should be placed as near the surface of the ground as practicable, so that the stairways should be as short as possible. The contract drawings provided that the passenger platforms in the stations should be at the level of the track. This arrangement permitted every portion of the edge of the platform, whether straight or curved, to be utilized for receiving and discharging passengers. After a conference with the railway officials it was decided to make the platforms about a foot higher than the rails, although this might result in throwing out of use, for receiving and discharging passengers, some of the curved portions of the platform. The requirements of wide platforms and wide stairways, combined with legal and other limitations, involved much curvature of tracks; and to avoid injury to private property near Hotel Pelham, near Park-street Church, and in other places, it was necessary to add still further to the curvature. The position of the platform near the surface of the ground, taken in connection with the sub-subway for the avoidance of grade crossings, required steep grades. The ascents and curves, however, are not more pronounced than those shown on the plans at the legislative hearings preceding the passage of the law creating the Boston Transit Commission, and are exceeded in numberless cases on electric surface railways in almost all parts of the country.

Studies for stations, tracks, etc.

The track, electric light, power, and other equipment of the subway has been made by the West End Street Railway Company and its lessee, the Boston Elevated Railway Company. The work has been done in a most substantial and satisfactory manner, and will help to insure the continued successful and safe operation of the subway.

A detailed statement as to the track and electric-light equipment, etc., is given in Appendix D.

METHODS EMPLOYED IN CITY STREETS.

It is well known that many of the streets of Boston have been during the busy hours greatly congested, and the inconvenience resulting from this congested condition led to the building of the subway. It is evident, therefore, that in carrying on our work it was desirable that there should be as little interference with the travel in the streets as was consistent with economy and reasonable expedition. By the Act creating the Transit Commission it is required "to so conduct the work of construction that all streets or places under or near which a subway is constructed shall be open for traffic between 8 o'clock in the forenoon and 6 o'clock in the afternoon."

Before deciding on methods to be employed in constructing the subway under the streets of Boston, some of the methods were examined that have been used for similar work elsewhere. This matter is discussed at considerable length and illustrated by various plates in the Second Annual Report.

Cut and Cover Methods.

Different methods of cut and cover work (some of which were designed to lessen to a greater or less extent interference with street traffic) have been made use of in London, Glasgow, Paris, and some other European cities. These methods are referred to at some length in the pages alluded to in the preceding paragraph.

The Shield Method.

This method — invented by Brunel — is sometimes known as the Greathead method on account of Mr. Greathead having been the first to make extensive use of it. It involves the use of a metal cylindrical tube called a shield. The advanced or head ends of the walls of the tunnel are built inside the rear end of the shield, which envelops these walls for a short distance as one tube of a telescope incases the next smaller tube. As excavation is made the shield is pushed forward by means of hydraulic jacks reacting against the end of the walls of the tunnel and against a rib or diaphragm inside the shield. The rear end of the shield, before it is pushed forward, may overlap the end of the tunnel to the extent of, say, two or three feet, and after this movement for a few inches only. After this advance the walls of the tunnel (usually made of segments of cast iron bolted together) are constructed for a distance equal to the advance. The shield thus serves to hold up the earth for a

few feet in advance of the permanent walls of the tunnel. The earth as excavated is carried to the rear through the shield itself and through the bore of the tunnel, and at some convenient place is hoisted by means of a shaft to the surface. The shield method.

One advantage of the shield method is that the surface of the ground is not disturbed at all under favorable circumstances, except at the shafts where the shields and masonry material are put in and where the earth is taken out.

This method has been exemplified in this country by the railroad tunnels under the St. Clair and Hudson rivers and by the gas tunnel under the East river; in Great Britain by several tunnels for electric, cable, vehicular, and pedestrian roads, and by a tunnel for a water-pipe; in France and Australia by tunnels for sewers. Its most extended use has been in the favorable deep bed of dry clay underlying the metropolis of London. Experience shows that this method is extremely valuable, but it also shows that in numerous cases other methods are at least equally safe, economical, and convenient.

Ninety-five per cent. of all the tunnelling by this method has been for sizes much too small to admit of the passage of a Boston street-railway car. Plate 14 shows the relative sizes of cross-sections of the Boston subway, of some structures built by the shield process, and of the Budapest subway. On account of the great complexity of the Boston subway and its very frequent changes of size and shape, it would have been impracticable to use shields continuously without very radical changes in design. A modified shield (for description of which see page 44) was, however, used on a portion of the subway.

Method of constructing the Subway in the Streets of Boston.

On the portion of the subway built in the Common, and on Sections 5 and 11 where ample space existed, the work was carried on in open excavation. The excavated earth, however, as fast as taken out, was immediately carried away, much of it being used to fill in and regrade the low portions of the Public Garden and of the westerly part of the Common.

All of the excavation in the city streets, except where tunnelling was resorted to on Section 6 (see page 44), was by cut and cover methods, but the surface was kept bridged over in such a manner that the traffic in the streets suffered little or no interruption, most of it being done so that only a small proportion of those travelling on the surface knew that the work of subway building was going on underneath.

Method of constructing the subway in the streets of Boston.

One method of cut and cover work first used on the subway is called "the slice method," this name being given because it suggests the method employed. The following slightly modified extract from the specifications for Section 4 describes it:

"Trenches about 12 feet wide shall be excavated across the street to as great a distance and depth as is necessary for the construction of the subway. The top of this excavation shall be bridged, during the night, by strong beams and timbering, whose upper surface is flush with the surface of the street. These beams shall be used to support the railway track as well as the ordinary traffic. In each trench a small portion, or *slice*, of the subway shall be constructed. Each slice of the subway thus built is to be properly joined in due time to the contiguous slices. The Contractor shall at all times have as many slice-trenches in process of excavation, in process of being filled with masonry, and in process of being backfilled with earth above the completed masonry, as is necessary for the even and steady progress of the work towards completion at the time named in the contract."

The method was such that the street-railway tracks were not disturbed at all, and the whole surface of the street, if desired, was left in the day-time wholly free for its normal traffic.

The slice method was used for much of the way on Section 4 and also on a portion of Section 6.

The other cut and cover method, used on Sections 7, 8, 8½, 9, and 10, may be briefly outlined as follows:

A narrow and short length of trench was dug at night on each side of the street, and bridged over before morning. Short lengths of the side-walls of the subway were built in these side-trenches. By repetitions of this process the whole side-walls were completed. At night a portion of the surface between the two side-walls was removed and transverse roof beams placed and the wooden bridging put across before morning. Most of the subsequent operations, such as building the roof, removing the remainder of the earth, and constructing the invert, were done from underneath. Plate 28 illustrates the manner of carrying on the work.

The work of construction on the Boston subway proceeded both day and night, and it was thought necessary also to work nearly every Sunday.

Debits for Street Occupancy.

The Contractor must necessarily use some portion of the public street for his shafts and plant. In order to encourage

him to use as little as possible, and in order to deal fairly with the contractors using more or less space, he was charged by the square foot for the space that he made use of on the surface of the street, the charge being varied somewhat according to the supposed value of the street for public use. Use of the public street inconsistent with the specifications was charged for at a double or triple rate, and other penalties were provided. Debits for street occupancy.

CROSS-SECTIONS OF THE SUBWAY.

The cross-sections adopted in different parts of the subway are described and illustrated in the detailed reports of the different contract sections given in preceding annual reports. These cross-sections are of three distinct types.

The wide-arch type has a roof consisting of an arch with its axis parallel to the subway, and having both arch and side-walls composed almost entirely of masonry.

The double-barrel arch type differs from the wide-arch type in that the roof spans from the side-walls to a middle wall.

The steel and masonry combined type has a masonry roof supported by steel beams running at right angles to the axis of the subway, the side-walls being of steel posts with concrete around and between.

The merits and demerits of these types were discussed at considerable length in the First Annual Report. The wide-arch type and the double-barrel arch type were employed in Sections 4 and 6 in Tremont street, where the traffic is great and space on the surface of the street is very valuable. One advantage of the wide-arch and double-barrel arch types is that they can be constructed by piecemeal, and all the materials for them can be conveniently sent from above the surface to the work below through much smaller holes or shafts than would be required for placing long and heavy roof beams such as are required in the steel and masonry combined type. The wide-arch construction employed on Section 6 permitted the use of the shield which was there employed.

The foregoing types are alluded to by their titles in the Condensed Statement beginning on page 37, and are illustrated by Plates 5, 6, 7, 14, 15, and 28.

The strength of the subway to support loading is treated in Appendix C.

CHANGES IN PIPES AND SEWERS.

The work of changing pipes and sewers was nearly completed during the year ending Aug. 15, 1897, and is now

Changes in pipes and sewers.

entirely completed with the exception of about 285 feet of 6-inch gas-pipe which has been removed, but is yet to be relaid, in Court street and Brattle street. The total cost of the changes has been about $142,000. Details regarding the work are given in Appendix A.

POSSIBLE CONNECTION OF THE SUBWAY WITH ELEVATED RAILWAYS.

As it was not thought probable by the Commission or its engineer that the traffic inside the subway would be by other than street railway cars, and as that traffic was certain to be very large, the subway was primarily designed for the use of such cars. The height, width, and curvature of the outside tracks is, however, such as to make it possible to run thereon cars of the Manhattan Elevated Railroad type.

The legislation of 1897 provides that under certain conditions, and upon the request of the Boston Elevated Railway Company, the Boston Transit Commission shall make such alterations in the subway as may be necessary to render it suitable for the running of cars and trains of cars through it in connection with the elevated structure.

Under this law an additional easterly platform, described on page 47, has been built at the Scollay-square station, a curve on the outer track at the head of Hanover street has been changed, and a change has been made in one of the stairways at the Park-street station.

DESIGNS FOR BUILDINGS OVER STAIRWAYS.

The eight buildings on Boston Common over the Boylston-street and Park-street station stairways were designed by Messrs. Wheelwright & Haven, and were constructed by Messrs. Norcross Brothers. These buildings are all of the same design (illustrated on Plate 9), have walls of cut granite, linings of white enamelled brick, and copper and glass roofs. They cost (including staircases and steel above the roof of the subway) about $11,000 each. The buildings in the centre and northerly end of Scollay square, and the one in Adams square, were designed by Charles Brigham, and were constructed by Messrs. Woodbury & Leighton. These are also of granite and to a considerable extent are roofed with glass. They are more ornate than those on the Common, and are illustrated by Plates 21, 21a, and 26. The building in the centre of Scollay square cost (including stairway) approximately $25,000, that in the northerly end about $10,000, and that in Adams square about $23,000.

The Engineer gave such data and assistance as were needed on the buildings mentioned in the foregoing paragraph, but had nothing to do with designing the structures. Designs for buildings over stairways.

The building covering the two stairways in the Haymarket-square station was designed by the Engineer. It is devoid of ornament, but is intended to be light, strong, durable, economical in design, and appropriate for the work it is called upon to do. It is described on pages 53 and 54. It is illustrated by Plates 32 and 33. Its cost was about $7,500.

The temporary building covering the entrance and exit stairways at the corner of Court and Brattle streets was also designed by the Engineer. A description of it is given on pages 48 and 49 of this report. In case a large building should be placed in this locality, this structure is so arranged as to strength of foundation, of first story, and of steel skeleton, that it could be incorporated in the larger building, and made to conform to almost any style of architecture which would be adopted. Its cost (including both superstructure and stairway) was about $9,800.

Disposal of Rain-water entering the Inclines, etc.

The rain-water which enters the subway from the open inclines is, together with a small amount of leakage alluded to in the next paragraph, lifted from 12 to 18 feet by automatic electric pumps to the city sewers. These pumps were furnished and installed by the Commission, and are described in Appendix D. As shown on the general map, the subway has a pump-well in the Public Garden, at Eliot street, Adams square, and Haymarket square. Plate 30 illustrates the well and chamber in Adams square. In each of these wells are two vertical submerged centrifugal pumps made entirely of composition metal. In each chamber above are two electric motors operating the pumps. Each motor is started and stopped according to the height of water by means of a float and an automatic release starting box. The floats are so placed that only one pump is usually brought into use. The other, however, comes into service in case the first pump is out of order or the water enters more rapidly than one pump can dispose of it. In the latter case both motors continue to run until the same low level has been reached. All but one of these pumping plants (the one in Adams square) take care of rain-water entering the inclines, as well as of percolation.

Very little dampness except from atmospheric condensation is to be found on the interior walls or roof of the subway, although numerous discolored patches, caused by

Disposal of rain-water entering the inclines, etc.

dampness and dust, can be seen on the walls of Sections 4 and 6. Substantially all of the leakage comes through the small drains in the invert leading from hollows left in the sidewalls. Careful measurement was taken at the end of an unusually wet season to determine the actual amount of leakage, and the total amount for the entire subway was found to be about 81 gallons per minute. About 8 gallons per minute of this flows by gravity into the Brattle-street sewer. The work (theoretical) of pumping the remainder is less than one-fourth of a horse-power.

SURPLUS EARTH.

The largest portion of the surplus earth was loaded on the Boston & Maine Railroad gravel cars and was hauled away at night without charge to the Commission. A smaller portion of the surplus earth was used for bringing some low portions of the Public Garden and of the Common to more desirable levels. A still smaller portion was filled on flats in Cambridge. The remainder was disposed of at various places, such as near the South Union Station, at Russia Wharf, etc.

VENTILATION OF THE SUBWAY.

Ventilating chambers have been built in connection with the subway as follows:

LOCATION.	No. of fans provided for.	Diameters of fans, feet.	Conditions, Aug. 15, 1898.
In front of Winthrop-school yard, Tremont street, Section 4	2	7	Fans installed but have not been put in operation.
Boylston-street mall of the Common	1	7	A small temporary fan has been running since June, 1898.
Tremont-street mall of the Common, nearly opposite West street	2	8	Fans installed but have not been put in operation.
King's Chapel yard	2	7	Fans not installed.
Cornhill, near Franklin ave.	1	7	
Hanover street, near Marston's restaurant	1	7	
Northeasterly corner of Hanover and Washington sts.	2	8	

The outlets of the two ventilating chambers in the Common are through small buildings; for the one in King's Chapel burial-ground, through an inconspicuous structure; for the others, through gratings on the surface of the side-

walk. A more detailed account of the fans and motors is given in Appendix D. Plate 29 illustrates the ventilating chamber and apparatus nearly opposite West street, and that in King's Chapel yard. The chamber and apparatus in Cornhill is illustrated on Plate 30. The subway south of Park street has now (Aug. 15, 1898) been in operation since the first of September, 1897. As already shown in the table at the beginning of this article up to the present time no fans have been made use of in the subway except the small temporary one in the chamber on the Boylston-street mall. So far as the writer is aware, however, from remarks in the press and from individuals, there has been little or no complaint about the quality of the air, but on the contrary, much satisfaction has been expressed as to its purity. There is a discussion of the question of ventilation on pages 43 and 44 of the First Annual Report. Ventilation of the subway.

Fatal and Serious Accidents.

Five men (4 laborers and 1 carpenter) lost their lives on the work of constructing the subway and another laborer lost an eye. No loss of limb is known to have occurred. Two of the men killed and the man who lost his eye were employed directly by the Commission while the remaining three were employed by contractors. As reported, all of these casualties were caused by the negligence of the workmen themselves or of fellow-workmen.

Estimated and Actual Cost of the Subway.

The estimated cost of the subway made before the work was begun was approximately $4,000,000, exclusive of land damages. Certain portions of the subway originally estimated to cost $360,000 have not been built. Certain portions not originally intended or estimated have been built at a cost of about $280,000. If the preliminary estimate should be amended by subtracting the first sum and adding the second it would be reduced to $3,920,000 for construction.

It is safe to say that the cost of construction (exclusive of additions authorized by the Acts of 1897) will not exceed $3,700,000. This includes ventilating and pump chambers; changes of water and gas pipes, sewers and other structures; administration, engineering, interest on bonds, and all costs whatsoever except those above stated.

Respectfully submitted,

Howard A. Carson,
Chief Engineer.

REPORT OF THE CHIEF ENGINEER FOR CHARLESTOWN BRIDGE.

GEORGE G. CROCKER, CHARLES H. DALTON, THOMAS J. GARGAN, GEORGE F. SWAIN, HORACE G. ALLEN, *Boston Transit Commissioners:*

GENTLEMEN: During the year ending Aug. 14, 1898, the engineer force of the Charlestown bridge has supervised all work under construction, and prepared plans and specifications for all of the steel superstructure necessary to complete the bridge, the water-proof flooring of the ten water spans, all masonry needed excepting such as may be required for the Boston approach, and for such portions of the draw fender pier and the northerly channel fender as can be completed before the removal of the old Charles-river bridge.

During the year the ten masonry piers, the main portions of the two abutments, eight spans of steel superstructure, and the greater part of the masonry and the foundations for the Charlestown approach, have been completed.

The testing of all cement used in the work has been carried on in the same manner indicated in the last report, the necessity of chemical analyses of different lots of the same, or new and untried brands of cement, being shown by the results obtained.

Nearly all of the cement used since Jan. 1, 1898, has been American Portland, the brands accepted being of uniform composition, and showing uniformly satisfactory results in the work.

CHARLESTOWN APPROACH.

The first contract of the year was that for three sections of the Charlestown approach, and it was let to Dennis F. O'Connell, Oct. 22, 1897. This contract included the masonry retaining-walls from City square to the Fitchburg Railroad, two abutments for the spans over Water street, one abutment for the span over the Fitchburg Railroad, a masonry pier between the railroad and a passageway under the bridge, and the pile and concrete foundations for a structure to be built to form that part of the approach between the passageway and the Charlestown abutment.

It having been decided to cross Water street with a bridge of two spans, a low masonry pier for supporting a steel trestle bent was designed, and the contract for building it was awarded to the above-named contractor.



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PLATE 38.



N. L. STEBBINS, PHOTOGR.

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GENERAL VIEW OF BRIDGE.

PLATE 39.

The structure between the passageway and the Charlestown abutment, designated as "Superstructure for Section 3, Charlestown Approach," is to consist of a one-story building with side and end walls of granite ashlar backed with brick, and alternate brick cross-walls and bents of steel columns for supporting the walks and roadway which also serve as a roof to the structure. The cross-walls and columns divide the interior of the structure into apartments about 25 feet in width, each provided with a large doorway at each end, and it is believed that they will prove of considerable value for storage purposes. The roof is to be made of steel beams supporting brick arches and concrete filling, upon which a water-proof stone paving and asphalt or granolithic walks will be laid. The posts of the elevated railway are to rest on the brick cross-walls before mentioned. The contract for this work was awarded to Woodbury & Leighton, and signed June 20, 1898.

The steel superstructure of the spans over Water street, the Fitchburg Railroad, and the passageway is to be furnished by the A. & P. Roberts Company, of Philadelphia, Pa., the contract for the same having been awarded on Aug. 4, 1898. The spans will be of similar construction to the roof of the superstructure of Section 3.

DRAW FOUNDATION AND FENDER PIERS.

The contract for this work was signed by Perkins, White, & Co., on Feb. 9, 1898, and work under it was commenced within a few days thereafter. This work embraces the building of the foundation pier for the draw span, and such portions of the fender pier for the same, and a channel fender for Pier 6, as can be built before the removal of the Charles-river bridge.

The foundation pier for the draw is to be made of Portland cement concrete with a granite coping ring upon which the lower track of the draw turntable will rest. In constructing the pier the bottom of the river was dredged to a level surface about 27 feet below mean low water, and 967 spruce piles driven within a circular space about 75 feet in diameter, and cut off from 2 feet to 4 feet above the dredged bottom. The wooden curb which retains the concrete forming the main portion of the pier is of somewhat novel construction, a view of it during construction being shown on Plate 41. It is approximately cylindrical, 72 feet mean diameter and 32 feet high. It is built of 3-inch by 12-inch spruce planks laid flatwise, there being 24 planks about 10 feet long in each course. The planks were planed on one

side to an even thickness, sawed to proper length and end bevel, and spiked and tree-nailed together. Hard-pine timbers, 4 inches by 12 inches, were placed vertically about 10 feet apart on the inside of the curbing and bolted to it as the laying of the planks proceeded.

The curbing was built in the water and kept in position by temporary radial arms connected with a ring placed about a central clump of piles, and by outside guide piles. As the building up of the curbing progressed, it was sunk by means of temporary pockets on the inside filled with concrete, and was finally sunk to the proper grade by pockets on the outside filled with gravel. This curbing has been filled with Portland cement concrete laid under water by the same method adopted for the ten masonry piers. From a point one foot below the top of the curbing, or 3 feet above mean low water, the pier will be in the shape of a truncated cone, and will be built inside of a wooden form, which will be left in place. Work under this contract has progressed rapidly and successfully, and the foundation pier is nearly completed.

DRAW SPAN AND TWO SPANS OF STEEL SUPERSTRUCTURE.

Plans and specifications for the draw span and the steel work of the two adjacent spans, Nos. 5 and 6, were prepared, and on May 19, 1898, a contract for building them was executed with the Pennsylvania Steel Company, of Steelton, Pa.

The draw span is to be a swing bridge 100 feet wide and 240 feet long, with a rim-bearing turntable 54 feet in diameter.

It is to carry two sidewalks, two roadways for highway traffic, one roadway for surface street cars, and two tracks of the Boston Elevated Railway Company. The dead weight of the draw complete will approximate 1,200 tons. Although several heavier draw spans have recently been built, it is believed that that for the Charlestown bridge will be the widest swing span yet designed for highway traffic.

The spans next to the draw span are to be similar to the eight spans now erected, differing only in the details at ends adjacent to the draw span, and in provision for the change of grade of the bridge at these spans.

ROADWAY FLOORING.

The roadway flooring for the ten water spans is to be of the following-described construction: Hard-pine spiking



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PLACING GIRDER FOR 85-FOOT SPAN.



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TIMBER CURBING. DRAW FOUNDATION PIER.

PLATE 41.



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DEPOSITING CONCRETE. DRAW FOUNDATION PIER.

PLATE 42.

pieces are to be bolted to the steel roadway stringers, and to these spiking pieces hard-pine flooring-plank, planed to an even thickness from 6-in. stock, is to be securely fastened with 10-in. steel wire spikes. After the planking is laid it is to be painted with two coats of a preservative compound, the exposed ends of the planking and the holes through it for the posts of the elevated railway flashed with copper, and copper expansion joints provided over eight of the piers and the abutments. A gutter curb of steel angle, so arranged as to provide for continuous surface drainage of the roadway, and for the difference in expansion between the roadway and walks, is to be placed at each side of the roadway.

The planking is to be covered with four thicknesses of roofing-felt laid in roofing-pitch, and on top of this felting one inch of road pitch and sand concrete is to be laid. The wearing surface of the roadway is to be of granite blocks laid upon a thin bed of sand, with the joints between blocks filled with pebbles and road pitch. Similar stone paving and water-proofing of felt and pitch concrete are to be laid on the structural work of the Charlestown approach, with the exception of the spans over the railroad and passageway, where, on account of the limited thickness of the bridge, the roadway surface will be of asphalt.

The hard-pine timber for the floor is to be furnished by George McQuesten & Co., the granite blocks by the Rockport Granite Co., and the laying of the same and furnishing the other materials for the flooring is to be done by D. J. Kiley & Co.

Painting.

The painting of the interior steel work of the ten water spans was included in the contract for laying the flooring, which provides for the application of two coats of Smith's Durable Metal Coating. It is the intention to delay the painting of the outside portions of all the steel work of the bridge till such time as it can be carried on simultaneously, and a uniform color and finish obtained.

Respectfully submitted,

William Jackson,
Chief Engineer for Charlestown Bridge.

APPENDIX A.

Changes in Pipes and Sewers.

(From the beginning until Aug. 15, 1898, inclusive.)

As stated on pages 63 and 64 of this report the work of changing pipes and sewers was nearly completed during the year ending Aug. 15, 1897, and is now entirely completed, with the exception of about 285 feet of six-inch gas-pipe which has been removed, but is yet to be relaid in Court street and Brattle street.

In general, wherever practicable, changes in sewers have been made a part of the regular contracts for the various sections of the subway; where not practicable they have been made partly by separate contracts, but principally by direct work by the Commission. Water-pipes have been laid by direct work. For making the changes in other pipes and in electric conduits, which were not done by the corporations owning the structures, the following contractors have been employed:

For relocations of pipes of the Bay State Gas and Boston Gas Light Companies, Alfred N. Farrington.

For relocations of conduits of the Edison Electric Illuminating Company of Boston, John S. Potter, until his death in April, 1898; since then Herbert S. Potter.

For relocations of conduits of the New England Telephone & Telegraph Company of Massachusetts, George H. Dresser.

For relocation of conduit of the Boston Electric Light Company, the National Conduit Manufacturing Company of New York.

The lengths and sizes of sewers, except those built as part of the direct or contract work on the subway proper, and of water and gas pipes and electric conduits relocated on account of the construction of the subway, are given in the following tables:

Sewers.

Size.	Linear feet removed.	Linear feet laid.
5 feet × 4 feet to 2.5 feet, wood and concrete (siphon)		108.0
4 feet × 4 feet, wood	127.0	17.0
30-inch × 33-inch, wood	40.0	55.0
30-inch cast-iron pipe (siphon)		180.3
24-inch × 27-inch, brick	134.0	
20-inch × 30-inch, brick	142.0	
20-inch × 24-inch, brick	25.5	
20-inch pipe		525.0
18-inch × 12-inch, wood	86.5	
18-inch × 12-inch, brick	156.5	
18-inch pipe		744.6
15-inch pipe	42.0	414.0
15-inch square, wood, brick, and stone	113.0	
12-inch pipe	169.0	951.7
10-inch pipe		208.0
8-inch pipe		638.4
3 manholes removed, 22 manholes built.		
2 manholes partially rebuilt.		
Total	1,035.5	3,842.0

Water Pipes.

SIZE.	Linear feet removed.	Linear feet laid.
40-inch	310.	380.
30-inch	1,954.9	2,021.3
30-inch Temporary		50.
24-inch	115.	115.
20-inch	263.7	191.6
16-inch	351.6	527.0
12-inch	2,042.5	2,662.6
8-inch	821.7	2,925.6
6-inch	1,455.1	176.
6-inch Temporary	26.	31.
4-inch	395.5	25.1
Gates removed, one 24-inch, two 20-inch, five 12-inch, two 8-inch, twelve 6-inch, two 4-inch.		
Gates set, one 36-inch, three 30-inch, two 24-inch, one 20-inch, two 16-inch, eleven 12-inch, 14 8-inch, seven 6-inch.		
Hydrants removed, 11.		
Hydrants set, 12.		
Total	7,736.0	9,105.2

Gas Pipes.

SIZE.	Linear feet removed.	Linear feet laid.
Bay State Gas and Boston Gas Light Companies.		
24-inch	943.	1,017.
20-inch	126.5	136.8
18-inch	1,949.5	2,050.3
12-inch	1,548.5	1,892.6
10-inch	13.	15.
8-inch	229.	191.3
6-inch	4,379.6	3,827.9
4-inch	73.	304.3
3-inch	43.	300.3
Gates removed, one 24-inch, four 20-inch, two 18-inch, seven 12-inch.		
Old-fashioned valve box, one 12-inch, one 8-inch, sixteen 6-inch, one 4-inch.		
Gates set, three 24-inch, four 20-inch, three 18-inch, seven 12-inch, three 8-inch, fourteen 6 inch, four 4-inch.		
Brookline Gas Light Company.		
12-inch	609.9	561.9
8-inch	187.	231.
6-inch	127.	154.
4-inch	67.	61.8
Gates removed, one 12-inch, one 6-inch, one 4-inch.		
Gates set, one 12-inch, one 6-inch, one 4-inch.		
Total	10,296.0	10,744.2

Electric Conduits.

SIZE.	Linear feet removed.	Linear feet laid.
Edison Electric Illuminating Company.		
3½-inch	320.8	320.8
3-inch	1,119.2	1,147.8
2½-inch	704.8	710.3
2-inch	1,783.3	1,819.3
Junction boxes removed, 8.		
Junction boxes set, 8.		
Total	3,928.1	3,998.2
Boston Electric Light Company.		
3-inch duct	2,950.0	1,096.0
3-inch duct, Temporary		591.0
New England Telephone and Telegraph Company.		
3-inch duct	19,268.5	16,853.9
Manholes removed, 17.		
Manholes built, 26.		
Western Union Telegraph Company.		
3-inch duct	1,725.0	1,759.4
Manholes removed, 2.		
Manholes built, 5.		

Care has been taken in all the changes to do the work at such times and in such a manner as to cause the least hindrance to the use of the streets and the use of the pipes themselves.

The approximate total cost of pipe relocations, except sewers built as part of day or contract work on subway sections is as follows:

Sewers	$32,050.00
Water-pipes	66,200.00
Gas-pipes	31,170.00
Electric conduits	12,800.00
Total	$142,220.00

APPENDIX B.

CEMENT.

There have been used from the beginning of the work to the date of this report approximately 148,500 barrels of Portland cement (mostly of German, but partly of American manufacture), and 4,500 barrels of Rosendale cement.[1] Information as to the tests which have been made is to be found in the preceding reports.

[1] The quantities have been erroneously stated in former reports.

APPENDIX C.

STRENGTH OF THE ROOF OF THE SUBWAY.

The material used for the framework of the subway is open hearth steel made partly by the acid and partly by the basic process.

The steel framework of the structure was designed to carry:

1. Its own weight, together with that of the concrete and masonry of the roof itself, and the covering of earth and paving above the same;

2. Either of the following live loads arranged in any possible position:

(*a.*) A steam road-roller surrounded by a crowd of people weighing 100 lbs. per sq. ft.; (*b.*) As many electric cars, weighing 18 tons apiece, as could be brought over the structure in question, all intervening and surrounding space being filled with a crowd of people weighing 100 lbs. per sq. ft.; (*c.*) A uniformly distributed load of 250 lbs. per sq. ft.

The road-roller, considered for the parts of the subway under the streets, was taken as weighing 50,000 lbs., while that used on the Public Garden and the Boylston and Tremont-street malls of the Common was assumed to weigh 36,000 lbs.

The fibre stresses allowed were:

	In Bending.		Compression in Posts.
	Under Common.	Under Streets.	
Rolled shapes . .	16,000	13,000	Under Common, 12,000 } Reduced by Gordon's
Girders	15,000	12,000	Under streets, 11,000 } Formula.

The stresses allowed are less than half those of the elastic limits of the material and more than half of the total assumed load is that caused by the dead weight of the roof and earth above the same, and it would be possible to treble the assumed live load on the Common without reaching the calculated elastic limit or sextuple it without reaching the calculated ultimate strength. On the streets this multiple could be still farther increased. Moreover, the actual strength of the subway is greater than the strength allowed in the calculations for the reason that the extra strength and stiffness derived from the concrete filling and corner braces, though shown by tests to be very considerable, was neglected in these calculations. It is hardly practicable to determine the strength of the masonry arch type employed on Section 4 and on Section 6, but it is safe to say that it is greater than that of the steel and masonry combined type.

The medium grade of steel was used for all plates and shapes and was specified to have an ultimate strength of 60,000 to 68,000 in tension per sq. in., with an elastic limit of not less than one-half the ultimate strength; to have a minimum elongation in a test-piece of not less than 20% in 8 in., with a reduction of area at the fracture of not less than 40%, and to bend cold 180° to a diameter equal to the thickness of the

piece without sign of fracture. Soft steel was used for rivets and was specified to have an ultimate strength in tension of 52,000 to 60,000 lbs. per sq. in., with elastic limit as before; to have a minimum elongation of not less than 26% in 8 in., with a reduction of area not less than 50%, and to bend cold 180° flat on itself, or when quenched from a low cherry-red heat in water at 70° F. to bend 180° around a diameter equal to its thickness without cracking.

For chemical properties the steel was allowed to contain not more of sulphur, manganese, and phosphorus than given in the table:

	Shapes.	Rivets.
Sulphur	.06%	.06%
Manganese	.90%	.90%
Phosphorus	Acid, .08% Basic, .06%	.06%

The carbon varied between .10 and .28%.

The elastic limit shown by actual tests varied between 29,500 and 46,000.

The workmanship was thoroughly inspected at every stage and all not conforming to specifications was rejected.

APPENDIX D.

EQUIPMENT OF THE SUBWAY.

(Statement furnished by the Boston Elevated Railway Co., of the work done in equipping the entire Subway.)

The work of equipping the subway with the necessary apparatus for the operation of the same has been done by the various departments of the Boston Elevated Railway Co., — the Department of Maintenance of Way, under Mr. Hapgood, installing the track; the Department of Wires and Conduits, under Mr. C. H. Hile, installing the trolley and feeder system; and the Department of Motive Power and Machinery, under Mr. C. F. Baker, the lighting system and other equipment.

The work has all been practically completed with the exception of drawing in some of the cables, which have not yet been received, and the installation of the ventilating fans.

Track.

The rails used are the standard of the American Society of Civil Engineers for steam railroads, and weigh 85 pounds to the yard. Each rail is protected for its entire length by a rolled steel guard of special section, weighing 43 pounds to the yard, which is securely bolted to the running rail. The joints are of the continuous pattern, giving a base support to the rails. Rolled steel tie-plates are used on each tie. The ties are of oak or chestnut, thoroughly treated with woodiline to exclude moisture, thereby insuring proper insulation, and also increasing their durability. Ties are laid in broken stone ballast.

The switches and frogs are of special design. The switches are arranged to be thrown by levers, fastened in place by steel wedges.

At the northern outlet of the subway, where the cars are obliged to cross from one track to the other, a switch tower has been erected, and the four switches at this point are controlled by means of levers from the tower.

Overhead Line Work.

An inverted wooden trough, made of kiln-dried cypress lumber, is securely fastened to the iron work of the roof structure, and special car-barn hangers are set flush into this trough. Sheets of rubber about one-quarter of an inch thick are placed both between the trough and iron work, and between the hanger and trough, for the purpose of deadening the noise as much as possible. The insulating bolt carrying a specially designed mechanical clip supports the trolley wire, which is also of special design, being in shape like a figure 8, and having a capacity of about 362,000 circular mills.

These hangers are placed about twelve feet apart on straight track, and as close, in places, as three feet apart on curves, making the construction at once very rigid, simple, and workman-like.

The trolley wire in the subway is separated by insulating joints from the overhead work outside, and in addition, it is divided into two sections at Park street, these sections being fed by separate cables. Conduits have been built on each side of the subway, the ducts being composed of cement-lined iron pipe laid in concrete; some terra-cotta conduit has

also been laid. The ducts are covered over with a smooth layer of cement, which serves as a walk at each side of the subway.

A new underground conduit of fourteen ducts has been built from Central Power Station to Pleasant-street entrance of the subway, via Shawmut avenue, a distance of thirty-five hundred feet; and the cables in general use for feeding the subway have been installed in this conduit. In addition, connections have been made with the main underground trunk line feeder system from Central Power Station to Adams square, via Albany and Devonshire streets, by means of branch conduits entering the subway at Pleasant street, Boylston street, Winter street, and Adams square; also connection with East Cambridge, Charlestown, and Harvard Power Stations is had by means of underground conduits entering at Scollay square and Causeway street.

By means of switches in connection with the various feeders and cables, not only can the cars in the subway be supplied with power by the means of the cables designed for that purpose, but if anything should happen to these cables, switches can be closed so that the cables that ordinarily supply the down-town surface lines can, by increasing the load on them to a slight extent, be used to feed the subway as well, or the subway can be fed in part from East Cambridge or other power stations. On the other hand, if it should be necessary, the subway cables can be used to help out the down-town surface lines.

In the subway itself the rails are used for the return circuit, being bonded at each joint with two 4/0 solid bonds, and the rails of all the tracks are tied together by a 500,000 circular mill jumper every five of six hundred feet. At Pleasant-street entrance a return independent of the rails, consisting of cables with a combined capacity of 2,500,000 circular mills is run to the Central Power Station, while at all entrances the track is connected to the outside return system.

The following table gives some of the material used in equipping the overhead lines of the subway:

Trough construction for trolley wire	23,625 feet.
Figure 8 trolley wire	23,362 "
1/0 and 2/0 trolley wire at entrances and loops	7,055 "
Barn-hangers and insulating bolts	3,093
Insulating joints	17
Feeder switches	35
Ground return, 500,000 c.m. cable, about	5,000 feet.
Number of feet of ducts in conduit in subway, alone, about	81,905 "
Manholes	63

In addition to the above, all small material necessary to make a first-class job, as well as the necessary amount of rubber and paper covered cable (not yet installed).

Lighting System.

Electricity was adopted as being the safest and best method for lighting the subway, incandescent lamps being used between stations and both incandescent and arc lamps at the stations.

The incandescent lamps are wired on what is known as the series-multiple system, the lamps being arranged in series of five, and each series connected between the positive and negative lead wires. The voltage used is that of the regular railway circuit, or about 500 volts, each lamp therefore taking about 100 volts, although lamps of lower voltage are used near the ends of the lines on account of the drop in voltage due to the resistance of the circuit. A portion of the arc lamps are also connected in series of five across the lead wires and supplied with current of 500 volts pressure, but the lamps, which are of the enclosed arc type and therefore only require trimming once every 150

hours, are so connected and combined with resistance coils that in case a lamp should cease to burn the resistance is connected into the circuit and the lamp cut out so that the remaining four lamps on that individual circuit will continue to burn as before. The remainder of the arc lamps are high potential enclosed arc, burning 150 hours without retrimming, the current being furnished by the Boston Electric Lighting Company. The current for the incandescent and the first-mentioned portion of the arc lamps is furnished from the power stations of the Boston Elevated Railway Company, cables of 500,000 circular mills capacity being run from the Central Power Station, and cables of 500,000 circular mills capacity from the Dorchester Power Station. These latter cables are provided with a connection at Central Power Station so that they can be supplied from that station in case anything should happen to Dorchester.

In addition, the various stations of the Boston Elevated Railway Company, seven in number, are connected together (with the exception of East Boston) so that any station could be helped out by the others; and this gives extra precaution for continuity of light.

In addition to the above a connection with 500-volt circuit of the Boston Electric Lighting Company is provided at the switchboard in the subway, and by means of a double throw switch all of the load carried by the Central Power Station can be transferred to the Boston Electric Lighting Company's system; and this is done each day to be sure that everything is in good working order.

It will thus be seen that four independent sources of light supply, besides the lights in the cars, are provided and in regular use, besides the opportunity to use the other power stations, and it is therefore almost impossible that all of these sources should fail at the same time and leave the entire subway in darkness. The incandescent lamps are arranged in lines on each side of the subway, and a circuit is also run between the tracks, this latter being the one supplied from Dorchester Power Station. The lamps from any one circuit are about 36 feet apart, but the various circuits are staggered in such a way that in the two-track sections the individual lights are only 12 feet apart, and in the four-track sections only 6 feet apart, running lengthwise of the subway, and therefore if any series of the five lights gives out it only means the loss of every third or sixth lamp out of a length of 15 or 30 lamps, according to the location, until the matter is attended to. At present there are installed in the entire length of the subway about 1,235 incandescent lamps. At the stations the incandescent lamps on the side-walls are retained, but the most of the light is obtained from the arc lamps, there being 136 of the enclosed arcs furnished from the 500-volt circuit and 39 enclosed arcs on the circuit of the Boston Electric Lighting Company. These lamps are wired in such a way that during the day-time, when considerable daylight penetrates into the stations, every other lamp can be cut out.

At the corner of Tremont and Boylston streets, over the sub-subway, a room about 24 feet × 17 feet is occupied as a centre of distribution for the electric system. Here is located a marbleized slate switchboard, consisting of three panels on which are mounted three circuit-breakers of 100 to 500 ampere capacity, two Weston ammeters of 0–250 and 0–200 ampere capacity, and six double pole, double throw switches. The circuit-breakers are connected to the positive cables from the Central Power Station, Dorchester Power Station, and the 500-volt circuit of the Boston Electric Lighting Company.

In addition, on the back of the board there are three more circuit-breakers connected to the negative side of the above-mentioned circuits. Wattmeters are also provided upon the various circuits so that the exact amount of power used can be determined. The wires from all the various branch circuits are connected to the various switches so that the

lights can be controlled from this point. The necessary fuses and magnet cut-outs are provided for each circuit. The current at 500 volts pressure, supplied from Central Power Station, varies from about 130 amperes to 180 or 190 amperes, and that from Dorchester is about 40 amperes. This room is provided with a desk for the use of the Chief Electrician, and is also provided with a work bench, with a vise, tools, etc., so that all small repairs can be made at once.

The electric current is used for many other purposes in the subway besides furnishing power for propelling the cars and lighting, among which may be mentioned running the pumps for draining the subway, fans for ventilation, counters for keeping track of the number of cars entering and leaving the subway, heating the ticket offices and other rooms, and signalling systems of various kinds, including alarm bells, telephone and watch-clock systems.

The pump chambers at Charles street, Eliot street, Adams square, and Haymarket square have been wired so that the motors for running the pumps can be run either from the circuit of the Boston Elevated Railway Company or from the circuit of the Boston Electric Lighting Company.

The method of operation of these pumps is of interest. The water collects in a reservoir below the floor, and when it reaches a certain height it raises a float that is connected by means of a chain with an automatic rheostat that starts one motor direct connected to a vertical submerged centrifugal pump that removes the water. When the water has fallen to a certain height the float descends and stops the motor. If it should happen that the first motor did not start the water on rising a little higher would start the reserve motor, and if that should not work and the water continue to rise an alarm bell at the centre of distribution will ring and give warning that something is wrong. This alarm consists of an independent float connected with a rod that, when it reaches a certain height, completes a circuit and causes a drop to fall at the centre of distribution and close a local circuit that rings a bell until it is stopped.

Duplicate pumps are used at each chamber, and they each have a capacity of about 300 gallons per minute, and are direct connected to five horse-power moters, and thus far have had no trouble in taking care of the water. There is one pump of larger capacity at Eliot street.

Fans.

Up to the present time only three sets of fans have been installed in the ventilating chambers, and these are all south of Park street.

One exhaust fan of 72 inches in diameter has been put in temporarily at Boylston-street chamber. This is being run through counter shafting by an electric motor, the current for the same being taken from the trolley circuit. Two fans each of 30,000 cu. ft. capacity per minute are being installed in the ventilating chamber between Hollis and Eliot streets, and two each of 37,000 cu. ft. capacity per minute are being installed in the chamber near West street. The fans are to be operated in pairs, and driven by motors supplied with current from the trolley circuit. The motors are to be direct connected to the fan shafts, and each pair so arranged that they can be run either in series or multiple.

Miscellaneous.

The ticket offices, the centre of distribution-room, the switch tower at the northern outlet of the subway, and the emergency rooms are all heated by electric heaters, the power for the same being taken from the trolley circuit. The lights in the ticket offices and clock towers are also supplied from the trolley circuit. A watch clock system with twelve stations located at the various pump-rooms, entrances, platforms, etc.,

has been installed, and thus a record is kept of the location of the watchman, etc.

Each platform is connected by telephone with the Company's telephone system, and in addition a system of telephones between stations is being installed so that the station masters can communicate with each other without calling up the central exchange.

Station Equipment.

On the platform at the foot of the entrance stairways, ticket offices have been constructed of suitable design for carrying on of the passenger traffic, there being twenty-seven in all. These offices, as mentioned above, are lighted with incandescent lights and heated by electric heaters. On the platforms at the foot of the exit stairways are located turnstiles through which exit may be made, but which bar entrance to the platforms. At Adams square and Haymarket square the ticket offices and turnstiles are at the top of the stairs in place of the bottom as at the other places.

Emergency rooms have been built in some of the stations into which any one taken sick or injured can be conveyed and remain until they can be removed. These rooms are equipped with a cot bed, chairs, table, etc., and are heated by electric heaters.

Power Stations.

In connection with this report a slight description of the power stations of the Boston Elevated Railway Company, especially those that usually supply the subway with light and power, may be of interest.

At present the Company has seven power stations, the normal capacity and location of each being as follows:

NAME.	Normal Kilowatts.	Normal Horse-power.	Location.
Central Power Station	[1]15,100	21,300	439 Albany St., Boston.
Dorchester	2,000	3,000	Freeport St., Dorchester
East Cambridge	3,150	3,900	North St., Cambridge.
Harvard	3,600	5,400	Boylston St., Cambridge.
Charlestown	1,600	2,000	George St., Charlestown.
Allston	744	1,000	Braintree St., Allston.
East Boston	600	1,050	Eagle St., East Boston.

With the exception of East Boston, which is located on an island, the stations are all connected by feeders and by closing or opening switches the various stations can be run multiple with, or independent of, each other.

Central Power Station. — This station which is the largest owned by the company was built in 1889 to 1891, and equipped with belted machinery, but in 1895 and 1896 was reequipped and altered, and at present contains six triple expansion, horizontal, condensing engines 23 in. 36 in. and 52 in. diameter and 48-in. stroke direct connected to 1,200 kilowatt generators; two cross compound, horizontal condensing engines direct connected to 1,500 kilowatt generators; and in addition the contract has been awarded and there is now being built one vertical cross compound condensing engine of 4,200 horse-power to be direct connected to a 3,000 kilowatt generator. The cylinders of this engine will be 42 in. and 90 in. in diameter and 60 in. stroke running at 75 revolutions per minute, with 180 lbs. of steam. This unit will be the largest ever built for street railway service. In addition to these

[1] With existing contracts filled

engines there is an auxiliary station containing 10 high-speed engines of 200 horse-power each, belted to 38 D–62 generators, which is used to help out in times of heavy load. All fly wheels in the main station are built of plate steel weighing 60 to 70 tons, 24 feet in diameter, and are practically indestructible. Each engine is provided with air pumps and condensers.

All the electrical controlling apparatus is located at the front end of the engine-room on a gallery commanding a view of the whole engine-room. Here are located the switch-board panels for each generator and also feeder panels connected to both the overhead and underground cables. In a separate building is located a complete set of apparatus for testing underground cables. The feed water is all handled by a series of six four-plunger gang pumps connected through countershafting to an electric motor.

The water from the city pipes passes through heaters and economizers to the boilers. The boiler-house contains 24 250-horse-power water tube boilers connected in pairs, and 8 500-horse-power double deck water tube boilers similarly connected. The chimney at this station is one of the highest in the city, being 252 feet above the yard, and the flue is 13 ft. 8 in. in diameter.

The manner of handling the coal is very interesting. The company has a large coal wharf on the opposite side of the street from the boiler-room. Here is located a travelling bridge crane of 150 feet span, provided with a bucket that picks the coal from the vessels in which it is received and drops it over the tunnels. The tunnels are provided with tracks, and the coal falls through the chutes into narrow-gauge side-dumping cars, which are hauled across the street and on to a trestle 2½ feet above the boiler-room floor level by a small mining locomotive, and the coal is delivered in front of the furnaces wherever it is needed, no trimming being required. Hand-firing is used.

Dorchester Power Station.

The Dorchester Power Station is built of brick and can be called the company's standard design. The boiler and engine rooms are under separate roofs, although the two rooms adjoin, being separated by a brick wall. The roofs are of the Guastavino type, made of fire-proof tile arches covered with asphalt and paper, supported by light steel trusses.

The chimney is circular in section with 10-foot flue and 200 feet high.

The equipment of the station consists of two cross compound, horizontal, condensing engines of 1,500 horse-power, each direct connected to 1,200 kilowatt generators. These engines are 26 in. and 50 in. in diameter by 60 in. stroke, and have practically indestructible fly-wheels. The station has the capacity for another unit of the same or larger size. Condensers, feed-water heaters and separators are used. Salt water is taken from the bay for condensing purposes and is returned through an open channel under the furnace ash-pits, carrying the ashes out of the station and depositing them within the timber bulkhead enclosure for filling. There are four 500-horse-power double-deck water tube boilers connected to the chimney through an economizer. The feed water is handled with a power pump belted through a countershaft to a 15-horse-power motor. The electrical instruments, together with the office, are located on a gallery which gives a view of the entire engine-room, while below are toilet, locker, and test-rooms, all built of steel and fire-proof construction. The coal is unloaded at the end of a long pier and is dumped in front of the boiler-room doors by automatic side-dumping cars working on the Hunt gravity system.

APPENDIX E.

TOTAL ESTIMATED QUANTITIES IN SUBWAY.

Excavation	369,450 cubic yards.
Concrete	75,660 cubic yards.
Brick	11,105 cubic yards.
Steel	8,105 tons.
Granite	2,285 cubic yards.
Piles	117,925 linear feet.
Ribbed tile	12,440 square yards.
Plaster	88,190 square yards.
Water-proofing (asphalt coating)	117,980 square yards.
Artificial stone	6,790 square yards.
Enamelled brick	2,210 square yards.
Enamelled tile	2,855 square yards.

APPENDIX F.

ARTIFICIAL STONE PLATFORMS IN SCOLLAY SQUARE, ADAMS SQUARE, AND HAYMARKET SQUARE STATIONS.

	Scollay Sq. Station.	Adams Sq. Station.	Haymarket Sq. Station.
	Included in one contract.		
Contractor	W. A. Murtfeldt Co., 192 Devonshire St., Boston.	W. A. Murtfeldt Co., 192 Devonshire St., Boston.	Simpson Bros. Corporation, 166 Devonshire St., Boston.
Sq. yds. of artificial stone 5 in. deep	674	000	000
Sq. yds. of artificial stone 3 in. deep	1,016	576	682
Sq. yds. of artificial stone 2 in. or less in depth (Composed entirely of surface material)	000	60	000
Date of contract	April 30, 1898.	April 30, 1898.	April 1, 1898.
Work begun	May 23, 1898.	May 11, 1898.	April 7, 1898.
Work substantially completed	July 12, 1898.	May 26, 1898.	May 17, 1898.

APPENDIX G.

ENAMELLED TILE AND ENAMELLED BRICK LINING TO WALLS OF SUBWAY STATIONS NORTH OF PARK STREET PUT IN PLACE DURING THE YEAR ENDING AUG. 15, 1898.

	Southerly and westerly walls of the Scollay Sq. Station.	Easterly wall of Scollay Sq. Station.	Adams Sq. Station.	Haymarket Sq. Station.
Contractor ...	John W. Hahn, 166 Devonshire St., Boston.	Grueby Faience Co., 164 Devonshire St., Boston.	M. J. Fitz Gerald, 164 Devonshire St., Boston	Grueby Faience Co., 164 Devonshire St., Boston.
Sq. yds. of enamelled surface	812	449	1,443	1,053
Date of contract.....	Feb. 25, 1898	April 27, 1898	Feb. 11, 1898	Nov. 10, 1897
Work begun..	April 9, 1898	June 6, 1898	Feb. 18, 1898	Dec. 15, 1897
Final certificate given..	June 7, 1898	Aug. 9, 1898	July 10, 1898	Mar. 2, 1898

APPENDIX H.

CANVASS OF BIDS FOR STEEL FOR HAYMARKET SQUARE STATION STAIRWAY COVERING, JULY 29, 1897.

BIDDERS AND ADDRESSES.	ABOUT 13 TONS.	
	Price per lb.	Totals.
Norton Iron Co., East Everett, Mass.	$0 07	$1,820 00
James Russell Boiler Works Co., 307 C street, So. Boston, Mass.	0 05½	1,430 00
Edward Kendall & Sons, Cambridgeport, Mass.	0 03 8/10	988 00

APPENDIX I.

CANVASS OF BIDS, OCT. 28, 1897, SECTION 11, SUBWAY.

Bidders and Addresses.	14,000 cu. yds. excavation above elev. 95.	300 cu. yds. excavation elev. 89-95.	250 tons iron and steel work, setting and securing.	120 cu. yds. brick masonry, Portland cement.	100 cu. yds. concrete masonry, Rosendale cement.	5,500 cu. yds. concrete masonry, Portland cement.	350 cu. yds. stone masonry.	100 cu. yds. coping stone masonry.	40 cu. yds. granite footing-stone.	650 sq. yds. coating of crude paraffine, etc.	600 sq. yds. tiling for outside of walls.	6,500 sq. yds. plastering, Portland cement.	40,000 lin. ft. spruce piles in place.	6,500 sq. yds. water-proof coating.	Totals.
	a	*aa*	*d*	*ee*	*f*	*ff*	*h*	*i*	*j*	*o*	*p*	*q*	*s*	*t*	
W. H. Keyes & Co.,	$1 65	$2 95	$10 00	$16 50	$7 50	$9 50	$17 50	$25 00	$35 00	$0 40	$2 00	$0 50	$0 135	$ 40	$104,365 00
Boston, Mass.	23,100 00	885 00	2,500 00	2,145 00	750 00	52,250 00	6,125 00	2,500 00	1,400 00	260 00	1,200 00	3,250 00	5,400 00	2,600 00	
National Contracting Co.,	1 97	2 50	9 77	14 50	6 50	8 50	19 55	24 73	23 57	0 23	0 75	0 46	0 14	0 40	102,105 30
Boston, Mass.	27,580 00	750 00	2,442 50	1,885 00	650 00	46,750 00	6,842 50	2,473 00	942 80	149 50	450 00	2,990 00	5,600 00	2,600 00	
Shailer & Schniglau & Co.,	1 00	3 00	10 00	16 50	8 00	9 00	16 50	26 00	25 00	0 40	1 00	0 35	0 14	0 30	89,905 00
Chicago, Ill.	14,000 00	900 00	2,500 00	2,145 00	800 00	49,500 00	5,775 00	2,600 00	1,000 00	260 00	600 00	2,275 00	5,600 00	1,950 00	
Richardson & Young,	1 20	2 50	8 00	15 00	7 00	8 00	19 00	25 00	15 00	0 25	1 00	0 35	0 18	0 25	87,812 50
Chicago, Ill.	16,800 00	750 00	2,000 00	1,950 00	700 00	44,000 00	6,650 00	2,500 00	600 00	162 50	600 00	2,275 00	7,200 00	1,625 00	
Charles Duncan,	0 98	1 50	7 00	15 50	5 50	8 45	22 80	27 50	19 25	0 20	1 08	0 37	0 15	0 33	87,788 00
Roxbury, Mass.	13,720 00	450 00	1,750 00	2,015 00	550 00	46,475 00	7,980 00	2,750 00	770 00	130 00	648 00	2,405 00	6,000 00	2,145 00	
H. A. Hanscom & Co.,	1 15	3 00	8 00	15 00	7 00	8 00	17 50	25 00	20 00	0 40	1 00	0 40	0 14	0 40	86,735 00
W. Medford, Mass.	16,100 00	900 00	2,000 00	1,950 00	700 00	44,000 00	6,125 00	2,500 00	800 00	260 00	600 00	2,600 00	5,600 00	2,600 00	
C. A. & C. E. Trumbull,	0 78	2 00	*9 00	17 50	6 40	8 00	17 54	27 77	17 54	0 20	1 00	0 40	0 15	0 40	82,232 60
Boston, Mass.	10,920 00	600 00	2,250 00	2,275 00	640 00	44,000 00	6,139 00	2,777 00	701 60	130 00	600 00	2,600 00	6,000 00	2,600 00	
E. W. Everson & Co.,	0 90	2 00	10 00	15 00	7 00	7 00	16 00	25 00	20 00	0 30	1 00	0 40	0 16	0 30	77,495 00
Providence, R.I.	12,600 00	600 00	2,500 00	1,950 00	700 00	38,500 00	5,600 00	2,500 00	800 00	195 00	600 00	2,600 00	6,400 00	1,950 00	
Charles Linehan,	0 70	0 90	5 00	15 00	5 00	6 50	16 00	23 00	28 00	0 25	0 30	0 35	0 11	0 30	67,507 50
Cambridge, Mass.	9,800 00	270 00	1,250 00	1,950 00	500 00	35,750 00	5,600 00	2,300 00	1,120 00	162 50	180 00	2,275 00	4,400 00	1,950 00	

APPENDIX K.

CANVASS OF BIDS FOR STEEL FOR ADDITIONAL EASTERLY PLATFORM IN SCOLLAY SQUARE. BIDS OPENED, FEB. 3, 1898.

BIDDERS AND ADDRESSES.	ABOUT 165 TONS.	
	Price per ton.	Totals.
New England Structural Company, 166 Devonshire street, Boston	$59 00	$9,735 00
The Carnegie Steel Company, L't'd, Pittsburgh, Pa.,	51 40	8,481 00
Passaic Rolling Mill Company, Paterson, N.J.	49 50	8,167 50
New Jersey Steel & Iron Company, Trenton, N.J.	47 60	7,854 00
The Berlin Iron Bridge Company, E. Berlin, Conn.,	46 69	7,703 85
Boston Bridge Works, 70 Kilby street, Boston	45 00	7,425 00
Edge Moor Bridge Works, Wilmington, Del.	39 67	6,545 55
Pennsylvania Steel Company, Steelton, Pa.	35 94	5,930 10

APPENDIX L.

CANVASS OF BIDS FOR ENAMELLED TILING, ADAMS SQUARE STATION. FEB. 5, 1898.

BIDDERS AND ADDRESSES.	Abt. 525 sq. yds. Straight Work. Price per sq. yd.	Abt. 165 sq. yds. Curved Work. Price per sq. yd.	TOTALS.
John W. Hahn, 166 Devonshire st.,	$7 67		$4,026 75
Grueby Faience Co., 164 Devonshire st.,	6 00	7 00	$3,150 00 1,155 00 $4,305 00
M. J. FitzGerald, 164 Devonshire st.,	5 58	6 21	$2,929 50 1,024 65 $3,954 15

APPENDIX M.

CANVASS OF BIDS FOR ENAMELLED TILING, SCOLLAY SQUARE STATION, FEB. 12, 1898.

BIDDERS AND ADDRESSES.	Abt. 405 sq. yds. of vertical work, including backing.	Abt. 250 sq. yds. Curved Work.	Abt. 100 sq. yds. vertical work without backing.	TOTALS.
	Price per sq. yd.	Price per sq. yd.	Price per sq. yd.	
Grueby Faience Co., 164 Devonshire st.	$5 89	$6 70	$5 15	$4,575 45
M. J. FitzGerald, 164 Devonshire st.	5 67	6 12	5 04	4,330 35
John W. Hahn, 166 Devonshire st.	5 55	6 25	5 55	4,365 25

APPENDIX N.

Canvass of Bids for Taking Down and Removing Building Numbered 77 Court Street, and Underpinning Adjacent Buildings, Feb. 26, 1898.

Bidders and Addresses.	Amount.
Isaac Blair & Co., Boston, Mass.	$14,587 45
Woodbury & Leighton, Boston, Mass.	13,800 00
John S. Jacobs & Son, Boston, Mass.	6,685 00

APPENDIX O.

CANVASS OF BIDS FOR GRANOLITHIC PLATFORMS AT HAYMARKET SQ. STATION, MARCH 31, 1898.

BIDDERS.	Quantity.	Price per sq. yd.	Total.
Aberthaw Construction Co.	548 sq. yds.	$1 85	$1,013 80
W. A. Murtfeldt Co.	"	1 70	931 60
Manhattan Concrete Co.	"	1 45	794 60
Simpson Bros. Corporation	"	1 38	756 24

APPENDIX P.

CANVASS OF BIDS FOR ADDITIONAL PLATFORM, EASTERLY SIDE OF SCOLLAY SQUARE STATION, APRIL 5, 1898.

BIDDERS AND ADDRESSES.	3,200 cu. yds. of earth excavation.	18 tons of old steel posts and beams to be removed.	130 cu. yds. of old masonry to be removed.	110 lin. ft. of 6-in. vitrified sewer-pipe.	170 tons iron and steel work, setting and securing.	40 cu. yds. brick masonry, Port. cement.	10 cu. yds. concrete masonry, Ros. cement.	866 cu. yds. concrete masonry, Port cement.	2 cu. yds. granite, footing-stones.	280 sq. yds. tiling outside of walls.	1,920 sq. yds. plastering, Port. cement.	1,920 sq. yds water-proof coating.	TOTALS.
	a	*bb*	*3b*	*c*	*d*	*ee*	*f*	*ff*	*j*	*p*	*q*	*t*	
Shailer & Schniglau Company,	$3 80	$10 00	$15 00	$0 75	$14 00	$17 50	$8 00	$10 50	$30 00	$1 25	$0 40	$0 35	$28,412 50
Chicago, Ill.	12,160 00	180 00	1,950 00	82 50	2,380 00	700 00	80 00	9,030 00	60 00	350 00	768 00	672 00	
George W. Judd,	2 85	2 50	5 00	0 50	10 35	19 50	7 00	8 50	35 00	1 00	0 50	0 35	21,771 50
95 Milk Street, Boston.	9,120 00	45 00	650 00	55 00	1,759 50	780 00	70 00	7,310 00	70 00	280 00	960 00	672 00	

APPENDIX Q.

CANVASS OF BIDS FOR ENAMELLED TILING, EASTERLY PLATFORM, SCOLLAY SQUARE STATION, APRIL 7, 1898.

BIDDERS AND ADDRESSES.	Ab't 400 sq. yds. Straight Work.	Ab't 50 sq. yds. Curved Work.	Totals.
	Price per sq. yd.	Price per sq. yd.	
M. J. FitzGerald, 164 Devonshire street.....	6 00	6 35	$2,717 50
Grueby Faience Company, 164 Devonshire street...	5 50	6 00	2,500 00

APPENDIX R.

Canvass of Bids for Tearing Down and Removing Buildings on Old Boston & Maine Property. Bids opened, April 21, 1898.

Name of Bidder.	Amount.
Wm. J. Lawler, 16 City square, Charlestown	$1,300 00
Edw. J. McHugh, 524 Bremer street, East Boston....	750 00
A. A. Elston & Co., 166 Devonshire street.....	475 00
Wm. F. Davis, 1 Mansfield place, Charlestown	100 00
J. J. Reagan & Co., 39 Haverhill street	90 00

APPENDIX S.

CANVASS OF BIDS FOR WOOD FINISH AROUND STAIRS, HAYMARKET SQUARE STATION, APRIL 22, 1898.

BIDDERS AND ADDRESSES.	Amount.
John Y. Mainland, 166 Devonshire street.....	$673 00
Estate of John A. Robertson, 161–169 Albany street..	647 67

APPENDIX T.

CANVASS OF BIDS FOR ARTIFICIAL STONE IN ADAMS SQ. AND SCOLLAY SQ. STATIONS OF THE SUBWAY, APRIL 30, 1898.

	Aberthaw Construction Co., 7 Exchange Pl., Boston.		Manhattan Concrete Co., 12 Brattle St., Boston.		Simpson Bros. Corporation, 16 Devonshire St., Boston.		W. A. Murtfeldt Co., 192 Devonshire St., Boston.	
500 sq. yds., 5 in. deep, gravel foundation, Scollay Sq. Station	$2 43	$1,215 00	$1 95	$975 00	$1 89	$945 00	$1 68	$840 00
500 sq. yds., 3 in. deep, concrete foundation, Scollay Sq. Station								
580 sq. yds., 3 in. deep, concrete foundation, Easterly Platform								
600 sq. yds., 3 in. deep, concrete foundation, Adams Sq. Station								
Total, 1,680 sq. yds., 3 in. deep, concrete foundation	1 89	3,175 20	1 60	2,688 00	1 49	2,503 20	1 52	2,553 60
40 sq. yds., 2 in. deep or less, concrete foundation, surface material, Adams Sq.	1 89	75 60	1.73	69 20	1 60	64 00	1 53	61 20
Abt. 10 cu. yds. Portland Cement, Base Course	8 10	81 00	8.50	85 00	7 95	79 50	8 00	80 00
Totals		$4,546 80		$3,817 20		$3,591 70		$3,534 80

APPENDIX U.

CANVASS OF BIDS FOR ERECTING BUILDING NO. 77 COURT ST., MAY 14, 1898.

BIDDERS AND ADDRESSES.	Amount.
W. A. & H. A. Root, Boston, Mass	$13,400 00
James H. Jacobs, 314 Newbury street	12,974 00
Norcross Bros., Boston, Mass	8,900 00

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